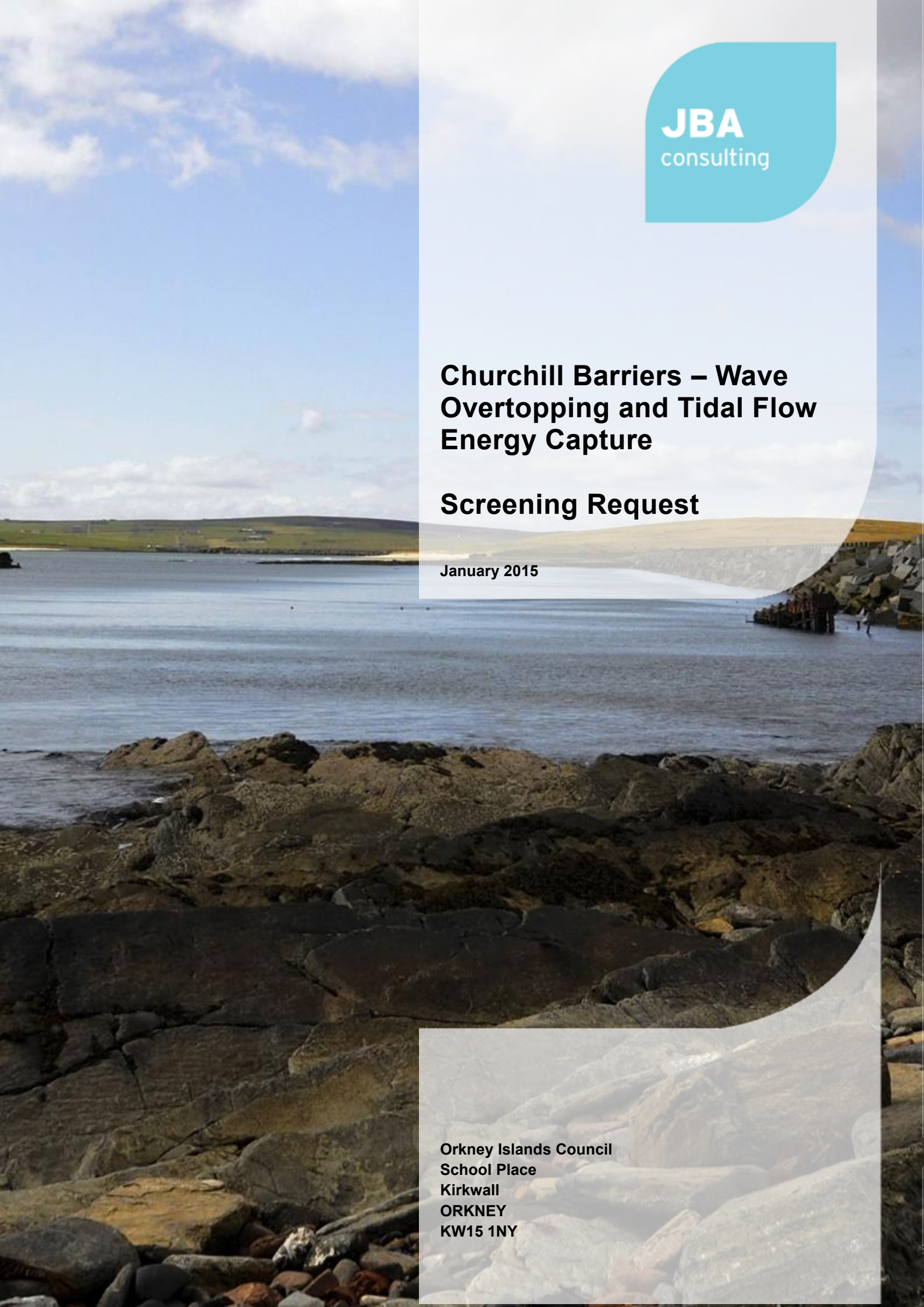

Churchill Barriers – Wave Overtopping and Tidal Flow Energy Capture

Screening Request

January 2015

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Revision History

Revision Ref / Date Issued	Amendments	Issued to
v _2015update_Final / 18 November 2015	Title changed Update of baseline data to include Barrier 1 Update of options Update of impact assessment to reflect revised options for both barriers	Peter Bevan
V_2015update_Nov_ RD_FT / 24 November 2015	Minor amendments	Peter Bevan
Environmental Appraisal_ 2015_Dec_FT_DB / 02 December 2015	Further amendments to text in Chapter 1 and Chapter 5. Change to title of document.	Peter Bevan
Environmental Appraisal_ 2015_Dec_FT_DBv2 / December 2015	Hydrography and bathymetry information added. Size of intended project (generative capacities and flows) added Correspondence/ consultation responses provided Indicative drawings for the scheme added Timescale of project and indicative working methods added. Further amendments to impact assessment	Peter Bevan
Environmental Appraisal_ 2015_Dec_FT_DBv2. 1 / January 2016	Further minor amendments	Peter Bevan

Contract

This report describes work undertaken by JBA Consulting, on behalf of Orkney Islands Council, by contract documentation issued 20 May 2013. Orkney Islands Council's representative for the contract is Peter Bevan. Jon Harrison, Frances Tobin, David Revill, Rachel Drabble and Salvador Ortigosa of JBA Consulting completed this work.

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Purpose

This document has been prepared as a Draft Report for Orkney Islands Council to be used to support the application for a Screening Opinion under the following regulations:

- The Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2000
- The Marine Works (Environmental Impact Assessment) Regulations 2007

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JBA Consulting has no liability regarding the use of this report except to Orkney Islands Council.

Acknowledgements

JBA would like to thank Orkney Wildlife Information & Records Centre for supply of data within 2km of the barriers. JBA would also like to thank staff at Frazer Nash and Orkney Island Council.

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Abbreviations

BWM ..... Ballast Water Management
CIEEM..... Chartered Institute of Ecology and Environmental Management
EcIA ..... Ecological Impact Assessment
EIA ..... Environmental Impact Assessment
HRA ..... Habitat Regulations Appraisal
JBA ..... Jeremy Benn Associates
JNCC ..... Joint Nature Conservation Committee
LDP ..... Local Development Plan
LWS ..... Local Wildlife Site
MAGIC ..... Multi-Agency Geographic Information for the Countryside
m/s ..... Metres per Second
MW..... Mega Watt
NGR ..... National Grid Reference
OWIARC ..... Orkney Wildlife Information and Records Centre
OIC..... Orkney Islands Council
PPG ..... Pollution Prevention Guidelines
PPP..... Planning Permission in Principle
RSPB ..... Royal Society for the Protection of Birds
SEPA ..... Scottish Environment Protection Agency
SNH ..... Scottish Natural Heritage
SAC..... Special Area of Conservation
SPA..... Special Protection Area
SSSI..... Site of Special Scientific Interest

1 Introduction

1.1 Purpose of this report

This report comprises the draft Environmental Appraisal in support of application for a Screening Opinion under The Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2000 and The Marine Works (Environmental Impact Assessment) Regulations 2007, for a tidal energy extraction scheme at Churchill Barrier 1 and/ or 2 and a wave overtopping solution at Churchill Barrier 2 only.

In this report the baseline environmental information has been collated and notable environmental features in the study area that have the potential to be affected by the proposed project have been identified. This report incorporates information obtained through a desk study exercise undertaken using readily available data sources and consultation with several organisations that hold information of relevance to this review. This information is then used to appraise the potential environmental benefits and impacts associated with the proposed scheme.

This report assesses the potential environmental impacts of all options at a high level for the opening one or both of the Barriers for a tidal energy scheme, in principle. Once the proposals have been fully developed and options have been designed and finalised full planning permission will be sought, supported by updated environmental assessments. The process is staged and based on the Rochdale Envelope[1] approach in which there is a noted requirement for design flexibility during the process.

In summary, this report covers the following aspects:

- Provides background and scope of the proposed scheme.
- Identifies the existing key baseline environmental conditions of the study area.
- Appraises the potential significant environmental impacts of the proposed project on notable environmental features.
- Sets out recommendations for further environmental assessment work required should the project be taken forward into the design phase and full planning.
- Identifies the organisations that would need to be consulted with to inform the detailed design phase.

1.1.1 Limitations of this study

This commission does not include the preparation of any formal Environmental Impact Assessment (EIA) or carrying out any environmental site surveys. All information used in this review has been obtained from a desk-study exercise incorporating readily available online data sources and a literature review, and through information requests to a range of relevant organisations.

1.2 Description of project

It has been proposed to incorporate tidal energy extraction at Barrier 1 and/or 2, whilst solving the overtopping issues at Barrier 2. Five options have been proposed, as follows:

- Re-facing Barrier 2 to be optimised as a wave overtopping solution with energy capture at Barrier 1 and/or 2.
- Remove section of Barrier and replace with bridge and free flow turbines for energy capture at Barrier 1 and/or 2.
- Remove section of Barrier and replace with structure for vertical axis turbines for energy capture at Barrier 1 and/or 2.
- Remove section of Barrier and replace with structure for horizontal axis turbines for energy capture at Barrier 1 and/or 2.
- Beach recharge at Barrier 2 with energy capture at Barrier 1 only.

[1] Using the Rochdale Envelope http://infrastructure.independent.gov.uk/wp-content/uploads/2011/02/Advice-note-9.-Rochdale-envelope-web.pdf

These options are currently being considered and will be narrowed down during project development. Indicative drawings have been provided in Appendix A-E. All drawings provided are for illustrative purposes to provide an example of what energy options might be used and are likely to be refined at a later stage.

1.2.1 Size of the Project

Tidal Energy Generative Capacity

The generative capacity for the Barriers has been estimated (JBA Consulting, 2015, Frazer Nash, 2015) and a summary of the tidal power predictions for different energy production scenarios has been provided in the table below. The maximum mean potential power that could be extracted from a fully opened Barrier 1 is 16.8MW. This is almost twice the maximum idealised mean power at Barrier 2 which is 8.8. When both barriers are opened the power prediction falls slightly to 16.7MW for Barrier 1 and 8.6MW to Barrier 2. Detailed modelling was conducted for Barrier 2 in terms of potential generative capacity of the tidal scheme, however this was not carried out for Barrier 1. The table shows the estimated figures for energy generation at Barrier 1 extrapolated from the data for Barrier 2, which will be refined later.

Table 1-1 Summary of different scenarios for tidal power extraction for the barriers.

Scenario	Predicted Mean Grid Power (MW)	
	Barrier 2	Barrier 1*
Theoretical maximum resource	6.5	12.6*
Turbines deployed off bridge (12 turbines)	1.0	1.9*
Turbines deployed off bridge (18 turbines)	1.4	2.7*
Tidal Fence (14 turbine)	2.8	4.8*
Turbines in culverts within barrier (10 turbines)	1.6	3.1*
Turbines in culverts within barrier (20 turbines)	3.0	5.8*

* Calculations based on figures for Barrier 2. Figures need to be confirmed.

1.2.2 Flow Velocity

Historic currents and flows at the site have been investigated through a background data review as described further in JBA Consulting 2015. Data from the 1909 Admiralty Chart reported flows through the pre-barrier channels of approximately 3m/s. The present arrangement of the Churchill Barriers, provides a largely impermeable connection between islands, preventing water from flowing in either direction through Holm Sound. The study carried out by HR Wallingford (2004)[2] provided estimate flows if one or both of the barriers are opened. These are summarised below.

- All barriers open, Kirk Sound (Barrier No. 1) typical peak tidal current velocity approximately 2.66m/s.
- All barriers open, Skerry Sound (Barrier No. 2) typical peak tidal current velocity approximately 3.05m/s.
- Single barrier open only, Kirk Sound (Barrier No. 1) typical peak tidal current velocity approximately 4.12m/s.
- Single barrier open only, Skerry Sound (Barrier No. 2) typical peak tidal current velocity approximately 3.25m/s.

2 HR Wallingford (2004) '2D Model Investigation into the Effect of Opening the Churchill Barriers on Tidal Flows'

1.3 Timescale

The indicative timescale and duration of the development are provided in the following table. This highlights the staged approach of the development.

Table 1-2: Timescale of Development

Task	Year of Completion
Screening Opinion	2016
Scoping Document	2016
Appointment of Design and Build Contractor	2017
Design Development	2017-2018
Project Consent	2019
Construction	2020-2022

1.4 Working Methods

The options are to be appraised and developed further as the programme progresses and working methodologies have yet to be identified in detail. It is considered that the working methods will be informed during the design process through results of ecological, historical and hydrological survey and investigation. Prior to the development of outline designs it is considered advisable to appoint a construction contractor to provide constructability advice. The barriers represent the only route between South Ronaldsay and Burray and the Orkney Mainland. It is considered to be unfeasible to carry out construction works under a complete barrier closure due to the need to maintain the transport link for access for emergency services and local through flow, for example. Options include:

- Constructing with one lane closure
- Erection of a temporary works causeway
- Constructing by sea

1.5 Study area

The Churchill Barriers are a series of four causeways located in the Orkney Islands in Scotland. They link Mainland, the main island in Orkney, with the island of South Ronaldsay, via a series of smaller islands that include Lamb Holm, Glimps Holm and Burray. The focus for this study is on Churchill Barrier No. 1 and 2, which provides causeways linking the mainland of Orkney to the islands of Lamb Holm and Glimps Holm and then Burray (see Figure 1-1).

This desk study seeks to identify features that could be affected by the proposed project options. The focus of this study and associated information search has been on the barrier itself and its general surroundings. Where required, this search area has been extended to take into account environmental features that could be affected by the project. For biological/ ecological features, the study area was extended to 2km around the barrier (10km in relation to nationally and internationally designated sites) to take into account potential species and habitat sensitivities, and the potential for mobile species that could be present in and around the area. For historical features a search area of 5km was applied to take into account potential impacts to the setting of these features within the landscape as a result from the works; a buffer of 500m was used to assess possible direct impacts to heritage features within proximity of the barriers. Furthermore, for contaminated land a search area of 1km was applied. The search areas used within this study were considered appropriate for the nature of the assessment.

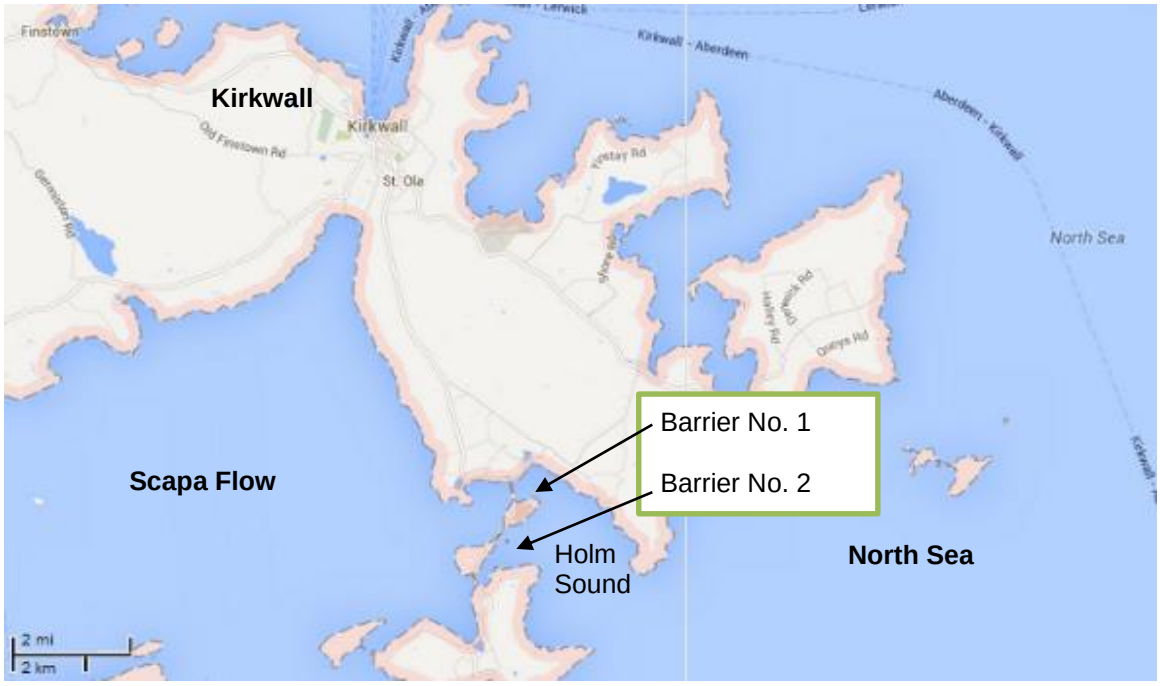

Figure 1-1: Location of Churchill Barriers No. 1 and No. 2 in Orkney

1.6 Sources of information

A desk study and consultation exercise was carried out to obtain baseline environmental information on key environmental features that have the potential to be affected by the project.

Where available, information has been collected in relation to the following topic areas:

- Biodiversity and nature conservation
- Historic environment
- Water quality and water resources
- Landscape, townscape and visual amenity
- Contaminated land
- Population
- Recreation and amenity
- Traffic and transport

The following online information sources were searched for relevant information:

- JBA Consulting (2004) Churchill Barrier No. 2 Wave Overtopping and Tidal Energy Assessment Final Report.
- Scottish Natural Heritage (SNH) Information Service (http://www.snh.gov.uk/publications-data-and-research/snhi-information-service/)
- Royal Commission on the Ancient and Historical Monuments of Scotland PastMap (http://www.rcahms.gov.uk/pastmap.html)
- Scottish Environment Protection Agency (SEPA) Interactive Map (http://gis.sepa.org.uk/rbmp/)
- Historic Scotland PastMap (http://www.rcahms.gov.uk/pastmap.html)
- The Orkney Islands Council Local Development Plan (LDP) (http://oldp.orkney.gov.uk/oldp-web/doc/areaSearchAction.do)
- Multi-Agency Geographic Information for the Countryside (MAGIC) (http://magic.defra.gov.uk/default.htm)
- Royal Society for the Protection of Birds (RSPB) (http://www.rspb.org.uk/ourwork/gis/);
- Biodiversity Scotland (http://www.biodiversityscotland.gov.uk/)

- Old-maps.co.uk (http://www.old-maps.co.uk/index.html)

A literature review was also been undertaken to obtain published information of relevance to the project. In addition, an Envirocheck® Report was obtained to provide further environmental data records and historical mapping.

Consultation was also undertaken with the following organisations to obtain information of relevance to this project:

- Scottish Natural Heritage
- Scottish Environmental Protection Agency
- Marine Scotland
- Orkney Wildlife Information & Records Centre
- Orkney Archaeological Trust
- Scottish Wildlife Trust

Details of consultations and correspondence are provided in the table below.

Table 1-3: Correspondence details

Organisation	Comment
Marine Scotland	Email correspondence July 2013. Referred query to SNH.
Orkney Archaeological Trust	Correspondence with Julie Gibson in July 2013. Verbal advice given that Canmore and Historical Environmental Records were suitable sources of baseline archaeological data at this stage.
Orkney Wildlife Information and Records Centre	Provided protected and non-native species data for a radius of 2km from the barriers. Data received for Barrier 2 on 15th July 2013. Data received for Barrier number 1 on 9th October 2015.
Scottish Environmental Protection Agency	Email sent week commencing 8th July 2013. No response.
Scottish Natural Heritage	Letter dated 29th July 2013 received in response to query. "There are no national or internationally designated sites within the area though there are other natural heritage interests to consider. These include; • Geomorphological process • European Protected Species (EPS) • Marine habitats & species • Landscape Impact and Visual Assessment (LIVA)"
Scottish Wildlife Trust	Email sent week commencing 8th July 2013. No response.

1.7 Appraisal of Potential Environmental Benefits and Impacts

A high-level appraisal of the proposed project options has been undertaken to identify potential significant environmental impacts. The outcomes of this process has been summarised in an appraisal matrix, which identifies the environmental features that have the potential to be affected by each of the project options and the potential significance of the effects identified.

2 Baseline review

This chapter provides a summary of the sensitive and notable environmental features present in the study area; for both Churchill Barrier 1 and Barrier 2. It includes important flora and fauna, heritage features and aspects of the environment including water quality, landscape character and quality, and recreation and amenity value.

2.1 Biodiversity and Nature Conservation

A desk study search was undertaken to identify the presence of sensitive species and habitats in the study area, which refers to the locations of both barriers and a given buffer zone. This includes a search of the Scottish Natural Heritage (SNH) website for designated nature conservation sites and a request to the Orkney Wildlife Information & Records Centre (OWIARC) for biological records relating to the study area. The general study area used to inform this information search was 2km, which was extended to 10km in relation to internationally and nationally designated sites.

2.1.1 Statutory designated sites

A search was undertaken to identify the presence of any statutory designated sites within 10km of the Churchill Barriers. The closest site to both barriers is Copinsay Special Protection Area (SPA), which is located approximately 8.8km and 9.2km to the East of Barrier 1 and Barrier 2 respectively. This site is designated for its aggregations of breeding marine birds, which include Great Black-backed Gull *Larus marinus*, Guillemot *Uria aalge*, Kittiwake *Rissa tridactyla* and Fulmar *Fulmarus glacialis*.

No other statutorily designated sites are located within 10km of either barrier. However, of note Orkney Mainland Moors SPA lies approximately 10.7km and 11.3km north-west of Churchill Barrier 1 and Churchill Barrier 2, respectively and is designated for several bird species including Hen Harrier *Circus cyaneus*, Red-throated Diver *Gavia stellata* and Short-eared Owl *Asio flammeus*, the former two being listed on Schedule 1 of the Wildlife and Countryside Act 1981 (as amended).

2.1.2 Local designated sites

Glimps Holm Island, located at the southern end of the Barrier 2, has been identified in consultation with Scottish Natural Heritage as a Local Wildlife Site (LWS), supporting nationally important habitats maritime cliffs and slopes and coastal sand dunes. Furthermore, it noted to be of interest for its Arctic Tern *Sterna paradisaea* and Common Gull *Larus canus* colonies[3]. There are no other locally designated sites, within 2km of the barrier.

2.1.3 Biodiversity Action Plan Habitats and Species

Orkney Local Biodiversity Action Plan (LBAP) 2013-2016 identifies actions for priority habitats and species which can be undertaken locally, but with the aim to make a contribution to the conservation of those species and habitats identified as being “at risk” or “threatened” in the UK as a whole. The following table lists the ten habitats included in the LBAP, highlighting those which are also listed as a UK Priority Habitat.

Table 2-1: BAP Habitats

Habitat	UK Priority (Y/N)
Lowland Fens	Y
Basin Bog	N
Eutrophic Standing Water	Y
Mesotrophic Lakes	Y
Ponds and Milldams	N
Burns and Canalised Burns	N
Aeolianite	N
Coastal Dunes and Slacks	Y
Coasted Vegetated Shingle	Y
Intertidal Underboulder Communities	Y

[3] Orkney Island Council (no date) http://www.orkney.gov.uk/Files/Planning/Outdoor-Access/SEA/CCPappendixB12008.pdf

In addition to these priority habitats the Orkney LBAP lists a total of 566 species (353 animals, 214 plants) which are considered to be of conservation concern in Orkney.

Coastal Vegetated Shingle habitat is found within close proximity to the barriers. The following species are associated with this habitat and are listed on the LBAP as a Local Priority Species:

- Cormmon Tern *Sterna hirundo*
- Arctic Tern *Sterna paradisaea*
- Ringed Plover *Charadrius hiaticula*
- Oystercatcher *Haematopus ostralegus*
- Wheatear *Oenanthe oenanthe*
- Oyster Plant *Mertensia maritima*
- Skullcap *Scutellaria galericulata*
- A Fly *Rhamphomyia morio*
- A Dolichopodid fly *Aphrosylus raptor*

Of these species Common and Arctic Tern are also on the Scottish Biodiversity List and on Schedule 1 of the Wildlife and Countryside Act (as amended). Furthermore, all of the bird species associated with Coastal Vegetated Shingle habitat listed above have been recently recorded within 2km of Barriers 1 and 2 (data from OWIARC).

2.1.4 Protected and Notable Species

Records for protected and notable species within 2km of Churchill Barrier 1 and 2 were obtained from OWIARC and have been compiled in the following subsections to provide relevant data within the study area. Records pre-2003 have been omitted from the list as older historical records are not considered to be relevant.

Birds

OWIARC records include a total of c.3000 records for bird species for the 2km study area around Barriers 1 an 2 within the past 10 years, which provides an important indication of the significance of this area for bird populations. A total of 189 of these records are located within 500m of the barrier and comprise 62 different bird species. The barriers themselves seem to be important for a number of bird species with OWIARC revealing that 46 different species have been recorded there.

Furthermore, amongst the records for birds within 2km of the barriers, over 1700 of these are individual records of birds on Schedule 1 of the Wildlife and Countryside Act (as amended). Of particular note 11 species protected under this legislation have been recorded at the barriers in the last 10 years. These are detailed in Table 2-2 below.

Table 2-2: Schedule 1 birds recorded at the Barriers.

Common Name	Latin Name	Location
Arctic Tern	*Sterna paradisaea*	Churchill Barrier 1 and 2
Black-throated Diver	*Gavia arctica*	Churchill Barrier 1 and 2
Common Tern	*Sterna hirundo*	Churchill Barrier 1 and 2
Great Northern Diver	*Gavia immer*	Churchill Barrier 1 and 2
Little Gull	*Hydrocoloeus minutus*	Churchill Barrier 1 and 2
Little Tern	*Sternula albifrons*	Churchill Barrier 1 and 2
Merlin	*Falco columbarius*	Churchill Barrier 1 and 2
Red-throated Diver	*Gavia stellata*	Churchill Barrier 1 and 2
Slavonian Grebe	*Podiceps auritus*	Churchill Barrier 1 and 2
Storm Petrel	*Hydrobates pelagicus*	Churchill Barrier 1 and 2
Sandwich Tern	*Sterna sandvicensis*	Churchill Barrier 2 Only

Bats

OWIARC records include three records for bat recorded in the past 10 years. These are shown in Table 2-3.

Table 2-3: OWIARC records for bat species in the study area

Common Name	Latin Name	Record year	Sighting location	Grid Reference
Pipistrelle Bat. Pipistrellus sp.	*Pipistrellus sp.*	2011	[redacted]	[redacted]
		2011	[redacted]	[redacted]
Nathusius Pipistrelle	*Pipistrellus nathusii*	2009	[redacted]	[redacted]

Otter

Otter *Lutra lutra* are protected under UK and European legislation[4] and it is an offence to deliberately damage, destroy or obstruct access to a breeding or resting place used by Otter.

[redacted]

Marine Mammals

SNH has confirmed that the coastal waters close to the barrier supports a range of cetacean species, which are protected under UK and European legislation. In particular, Harbour Porpoises *Phocoena* are known to be resident in the area and a number of dolphin species have been recorded in St Mary's Bay and close to Glimps Holm. SNH confirm other species of cetacean have been recorded in the area including Minke Whale *Balaenoptera acutorostrata*, Orca *Orcinus orca* and Sperm Whale *Physeter macrocephalus*.

In addition, OWIARC records include a number of cetacean species within 2km of the barriers. These records are shown in Table 2-4.

Table 2-4: OWIARC records for cetacean species

Common Name	Latin Name	Record year	Sighting location	Notes
Minke whale	*Balaenoptera acutorostrata*	2002	Holm Sound	Length c 15 metres.
		2008	Burray Haas	Dead length 4.9 metres.
		2011	Holm	5 metres
Sperm Whale	*Physeter macrocephalus*	n/a	East Mainland	Brit. Mus., 1927. Length 7.3 metres
Cuvier's beaked whale	*Ziphius cavirostris*	2004	East of No 1 Barrier	
Harbour porpoise	*Phocoena phocoena*	2004	No. 1 Barrier	Reported by Keith Hague. Very active , all ages, breaching
		2010	St Marys,	Freshly dead, length 1.07 metres
Short-beaked Common Dolphin	*Delphinus delphis*	2000	St Mary's Bay	Feeding on shoals of fish off No 1 and No 2 Barriers, Scapa Flow side. Both adults and juveniles in school.
		2009	Glimps Holm	Long dead on shore, length 1.26 metres

Common Name	Latin Name	Record year	Sighting location	Notes
Atlantic white-sided dolphin	*Lagenorhynchus acutus*	2004	Lamb Holm	Dead some time, length 2 metres
		2006	No 1 Barrier	Probably live stranded. Length 2.35 metres
White-beaked dolphin	*Lagenorhynchus albirostris*	2000	No 2 Barrier	East side of barrier. Only an adult male but someone else thought to have seen 3
Orca whale	*Orcinus orca*	2005	West of No 1 Barrier	Also seen on 13/5 reports from several people. Spy hopping and tail slapping. Also off No 2 Barrier
Risso's dolphin	*Grampus griseus*	2006	No 2 Barrier	
		2007	No 1 Barrier	
		2008	Burray Haas	Fairly freshly beached, length 4.9 metres. Being scavenged by gulls
		2009	St Marys Bay	Seen off Scapa on 29/06/2009

Marine fish

SNH has confirmed that Basking Shark *Cetorhinus maximus* has been recorded in the study area. Although not a species protected under European law, it is offered the same level of protection under UK law. Furthermore, OWIARC provided records of Basking Shark within 2km of the barriers, below.

Table 2-5: OWIARC records for Basking Shark

Year	Location
2000	East side of Barrier 1
2004	Hunda Sound
2004	Harraborough Head
2005	Bay of Ayre Holm
2006	Widewall Bay, South Ronaldsay
2007	Copinsay

Other marine species

SNH reports that *Maerl* (coralline red algae/seaweed), *Zostera* seagrass and Horse Mussel *Modiolus modiolus* beds are present in coastal waters around Orkney. Historic records (1994 to 1998) provided by OWIARC indicate the presence of Horse Mussel at Glimps Holm. However, the presence and extent of this species in the study area is not known. Horse Mussel beds are a priority habitat for UK Biodiversity Action Plans (BAPs) and are included within the Scottish Biodiversity Strategy[5] prepared by the Scottish Government.

Plants species

The dune system that has developed at the side of a number of the Churchill Barriers since their construction is a major site for the nationally scarce Oyster Plant *Mertensia maritime*, which is also an Orkney LBAP priority species.

2.1.5 Invasive non-native species

OWIARC data included one record for invasive non-native species within 2km of the barriers. Japanese Skeleton Shrimp *Caprella mutica* were recorded at Buoy 2, Holm, Orkney in 2013. No other records of invasive non-native species were returned from the data search.

[5] The Scottish Government (2004), Scotland's biodiversity in your hands
http://www.biodiversityscotland.gov.uk/doing/framework/strategy/

2.2 Historic Environment

A search was undertaken to identify the presence of any historic environment features within close proximity to Churchill Barrier 1 and 2. These are features that have the potential to be impacted by modifications to the barrier either due to direct impacts on the fabric of the structure or due to changes to its setting. This includes a search for designated sites including Scheduled Monuments and Listed Buildings, and local historic sites and features.

Information to inform this desk study was obtained from the Historic Scotland website, the Orkney Islands Council Historic Environment Record (HER), historic map sources and other online databases.

2.2.1 Scheduled Monuments and Listed Buildings

Scheduled Monuments

There are six Scheduled Monuments within 5km of the barrier. The closest comprises the remains of a prehistoric (Neolithic or Iron Age) settlement on Lamb Holm island, located approximately 400 metres to the north of Barrier 2 and 300m south east of Barrier 1 (see Figure 2-1). Historic Scotland records state 'The monument consists of the remains of a prehistoric settlement which is beginning to appear in an eroding coastal section on the shore of St Mary's Bay' and 'The monument is of national importance as a recently-discovered settlement site of prehistoric date which appears to have suffered little from marine erosion, and which has walling surviving to an unusually good degree.'[6]

Table 2-6 provides further details of the scheduled monuments present in the study area, including site name, location (National Grid Reference, NGR) and comments about each designated feature. Furthermore, their proximity to each barrier has also been provided.

Table 2-6: Scheduled monument located within 5km of Churchill Barriers 1 and 2

Number	Site Name	NGR	Notes
1	Lamb Holm, Settlement 450m WSW of Italian Chapel	HY484 005	The monument consists of the remains of a prehistoric settlement. Located 0.3km and 0.4km from Barriers 1 and 2, respectively
2	East Broch of Burray	ND489 988	Broch that was excavated in 1852.Contains a number of chambers, some now filled with vegetation. Located 2km and 1.3 km from Barrier 1 and 2 respectively.
3	Loch of Ayre, Broch at north end of St Mary's	HY470 013	Broch that was excavated in 1901-2.The complete outline still visible although some walls are fragmented. A number of artefacts have been found here including a number of bone dice. Located approximately 1.3km and 1.8km from Barriers 1 and 2 respectively.
4	Castle Howe Broch 400m NW of banks	HY513003	No information available. Located approximately 3km from Barriers 1 and 2.
5	Cornquoy Barrow 200m SSE of Holm	ND523996	Bronze Age burial mound located approximately 4.2km east of Barriers 1 and 2.
6	North Cairn, Rose Ness	ND526992	No information available. Located 4.2km and 4.7km from Barriers 1 and 2 respectively.

Listed buildings

There are 24 Listed Buildings within a 5km radius of the barriers and eight of these Listed Buildings fall within 2km of the barriers. The locations of these listed buildings in relation to the barriers are given in Figure 2-1, below. Details all listed buildings, including brief descriptions and their proximity to each barrier, are provided in Table 2-7.

[6] Historic Scotland, scheduled monument record http://data.historic-scotland.gov.uk/pls/htmldb/f?p=2300:35:984290154300743::::P35_SELECTED_MONUMENT:06246

Table 2-7: Listed buildings located within 5km of Churchill Barrier No. 1 and 2

Site name	NGR	Category	Description and Proximity
Lamb Holm The Italian Chapel, including Statue	HY 4882 0062 and HY 4870059	Grade A	A Chapel constructed between 1942 and 1944 by Italian prisoners of war, located approximately 0.3km and 0.8km from Barriers 1 and 2 respectively. It is a single storey, gable-fronted chapel and a statue.
St Mary's Village, Elrose including boundary Walls	HY 4719 0131	Category C	Single-storey cottage constructed in the early 1900s. Located approximately 1.1km and 1.7km from the northern extent of Barrier 1 and 2 respectively, in the village of St Mary's
St Mary's Village, The Pier	HY 4756 0130	Category C	Long, low rectangular rubble pier constructed in 1877 and extended later. Located approximately 0.8km and 1.4km of the northern extent of Barrier 1 and 2, respectively, it extends south east from the Orkney mainland into St Mary's Bay.
St Mary's Village, The Corn Store	HY 4775 0135	Category B	A 2-storey storehouse/granary and attic with crowstepped gables to steeply pitched roof constructed in 1608. Located approximately 0.6km and 1.4km from the northern extent of Barrier 1 and 2 respectively, in the village of St Mary's.
St Mary's Village, Former Temperance Hall	HY 4744 0138	Category C	5-bay symmetrical rectangular-plan former Temperance Hall constructed in the late 19th century. Located approximately 1.6km and 0.95km of the northern extent of the Barrier 1 and 2, respectively, in the village of St Mary's.
Graemeshall, including boundary walls gatepiers and and walled gardens	HY 4876 0017	Category B	This listed building comprises 5 separate structures including a two storey and attic 6 x 4-bay Scots Jacobean asymmetrical crowstepped-gabled manor house and chapel with various additions to rear forming courtyard. The buildings are located approximately 0.5km and 1.7km from the northern extent of Barriers 1 and 2, respectively.
Hestikeday Farm Steading	HY 4954 0020	Category B	Located approximately 1.4km and 2.5km from Barrier 1 and 2, respectively, this building comprises a late 18th-early 19th farm steading and accompanying outbuildings, displaying good examples of traditional building techniques and forms
Little Millhouse	HY 4898 0025	Category C	A 19th Century building with graded stone tiles and the simple, original interior. This building is located approximately 1.4km and 2.6km from Barrier 1 and 2, respectively.
Howa, including Kiln	HY 4593 0031	Category C	Located approximately 3.1km and 3.9km from Barrier 1 and 2 respectively. Earlier to mid-19th century, a single storey, 2-bay farmhouse.
Netherbutton	HY 4593 0044	Category C	Located approximately 4.0km and 5.0km from Barrier 1 and 2 respectively. Late 19th century with later alterations and additions. Single storey, 6-bay long rectangular-plan farm steading with single storey lean-to additions to rear.
Holm Smithy	HY 4775 0028	Category C	Located approximately 1.7km and 3km from Barrier 1 and 2 respectively.Mid-19th century, single storey, 3-bay symmetrical, rectangular-plan former Smithy's cottage.
Holm Smithy Cottage	HY 4775 0028	Category C	Located approximately 1.7km and 3km from Barrier 1 and 2 respectively. Mid-19th century single storey, 3-bay symmetrical, rectangular-plan former Smithy's cottage.
Canniemyre	HY 5084 0039	Category C	Located approximately 3.6km and 4.7km from Barrier 1 and 2 respectively. Mid-19th century single storey 4-bay asymmetrical rectangular-plan farm cottage with lean-to additions.
Sebay Mill	HY 5155 0046	Category B	Located approximately 4.6km and 5.8km from Barrier 1 and 2 respectively. Circa 1854. 2 1/2 storey, 4-bay L-plan near-symmetrical mill with (later?) 2-storey lean-to addition to internal angle at rear. Roughly

Site name	NGR	Category	Description and Proximity
			coursed rubble.
Holm, former united presbytarian manse	HY 5039 0018	Category B	Located approximately 2.1km and 2.8km from Barrier 1 and 2 respectively. A mid-19th century 2-storey, 3-bay square-plan symmetrical manse with later alterations and additions
Holm, former united presbytarian manse outbuilding	HY 5039 0018	Category B	Located approximately 2.7km and 2.8km from Barrier 1 and 2 respectively. Rebuilt, 1781, renovated (or rebuilt again) 1816-1818 5-bay, symmetrical, rectangular-plan, crowstepped gabled, plain hall church with low 2-bay rectangular-plan vestry to E end.
Holm, St Nicholas' Church	HY 5104 0006	Category B	Located approximately 3.1km and 3.5km from Barrier 1 and 2 respectively. An irregularly fenestrated 2-storey, L-plan roughly coursed rubble barn sited to north of main house with various single storey lean-to additions to N elevation. Grey slate; stone ridge; corrugated-iron roof to additions; concrete skews.
Greenwall House Barn and Byre	HY 5142 0013	Category B	Located approximately 3.1km and 3.5km from Barrier 1 and 2 respectively. 2-storey, 3-bay rectangular-plan roughly coursed rubble mill sited to rear of main house, with stone forestair to south gable.
Greenwall House Mill	HY 5142 0013	Category B	Located approximately 3.1km and 3.5km from Barrier 1 and 2 respectively. A 2 storey building with attic dated 1656 with later alterations and additions.
Greenwall House	HY 5142 0013	Category B	Located approximately 3.5km from Barriers 1 and 2. Earlier-mid 19th century 2-storey, 3-bay rectangular-plan near-symmetrical house with lean-to projection spanning bays at right to rear.
East banks including outbuilding	HY 5173 0001	Category C	Located approximately 3.6km and 2.5km from Barrier 1 and 2 respectively. Mansion built c. 1800 on site of The Bu. 3 storeys; 3 bays wide with porch. Harled
Burray, Bu of Burray	HY 4851 9705	Category B	Located approximately 4.3km and 3.4km from Barrier 1 and 2 respectively. Dated 1621, an oblong structure with random rubble with moulded doorway and windows. Roofless.
Burray, South Town, St Lawrence's Church	HY 4917 9642	Category B	Located approximately 5.4km and 4.2km from Barrier 1 and 2 respectively. Dated 1645. 2 storey structure with loft.
Burray Westshore, storehouse	HY 4684 9550	Category B	Located approximately 3.1km and 3.9km from Barrier 1 and 2 respectively. Earlier to mid-19th century. Single storey, 2-bay farmhouse.

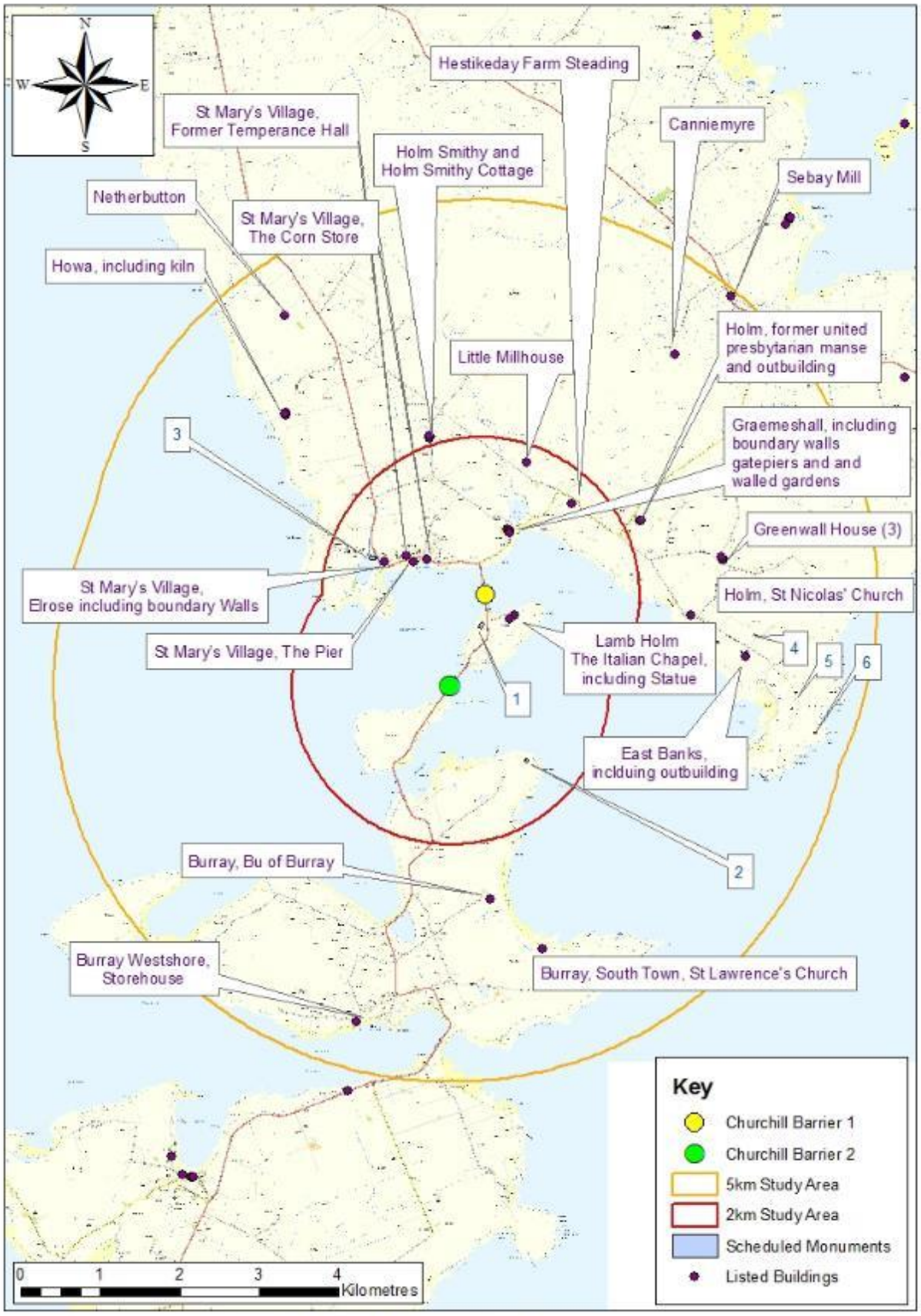

Figure 2-1: Listed Buildings and Scheduled Monuments located within 2km and 5km of the Barriers

2.2.2 Local Historic Sites

There are a significant number of Historic Environment Records (HER) sites present in close proximity to the barrier and also in the surrounding area. Table 2-8 provides details of the HER records located within 500 metres of the barriers. Of particular note, both barriers are listed on HER as an important historic feature. Many of the HER records relate to historic shipwrecks known as 'blockships' located both east and west of the barrier. These are ships scuttled during the Second World War to create a secure defensive barrier around Scapa Flow, evidence of which still survives in close proximity to the barrier.

Table 2-8: HER records located within 500m of Churchill Barrier No. 1 and 2

Site Name	NGR	Description
Churchill Barrier No.1	**HY48440098**	**The Churchill Barriers were completed in the latter stages of the Second World War.**
Churchill Barrier No. 2	**HY48039975**	
Ac6: Skerry Sound, Scapa Flow, Orkney	ND 48120 99608	**Barge, crane barge. 20th Century.**
Almeria (Wreck)	ND 48266 9761	A steel single-screw steamship, built in 1888 and originally purchased as an accommodation ship. It was later sunk as a blockship in 1915.
Aorangi (Wreck)	HY482 006	Sunk WW1. Steel single-screw steamer Raised by East Coast Wrecking Co. and resunk off Holm kirkyard
Ayresdale or Northfield	ND48559878	This gun battery built adjacent to a broch (ND49NE 2) consisted of one twin 6 pounder, but was by July 1940 increased to two 6 pounder guns. The guns were removed in 1943. The associated buildings survive, but not in the usual layout.
Broch of St Mary`s, Mainland	HY47020136	The Broch and outbuildings were excavated 1901.
Bu Sands	ND48509750	Scattered finds, extensive horizons of organic midden deposits, broken-off orthostats and scant wall foundations have been noted over several acres. This is the result of past and present sand extraction.
Busk (Wreck)	HY482 003	Sunk 1940. Steel single-screw steamer.
Cape Ortegal (Wreck)	ND482 997	Sunk in 1939. Steel single-screw steamer.
Carron (Wreck)	ND481 953	Sunk 1940. Steel single-screw steamer.
Chapel of Lamb Holm	HY48270000	Site of a small building locally believed to have been a Roman Catholic chapel. It is listed.
Clads Ber	HY46450089	Four concrete mast bases and a concrete building that may have been used for radar or radio purposes.
Clio (Wreck)	ND482 950	Sunk 1914. Steel single-screw steamer.
Cornquoy	ND52379966	Bronze Age barrow. At location ND 5234 9968 there is a disc barrow in good condition.
Culdiegeo	HY49910505	Next to the N boundary of New Holland farm
East Broch of Burray	ND48979881	Scheduled Ancient Monument Excavated Iron Age/Pictish Broch
Elton (Wreck)	ND482 995	Sunk 1915. Steel single-screw steamer.
Burray Ferry (Wreck)	ND480 995	Sunk 1940. Steel single-screw steamer. Approximately 80m south east of the south of Barrier 2.
Empire Seaman (Wreck)	ND471 984	It was sunk 1940. Steel single-screw steamer
F/C Pontoon (Wreck)	ND482 996	Sunk 1941.
Gambhira: Kirk Sound, Scapa Flow, Orkney	HY47950119	Steamship (20th Century)
Gartshore (Wreck)	ND471 985	Sunk 1915. Iron single-screw steamer.

Site Name	NGR	Description
Gondolier (Wreck)	ND481 948	Sunk 1940. Iron paddle steamer.
Graemeshall	HY48770165	Possible artificial burial mound; is insignificant in size and neat in appearance. It is topped by a cairn
Graemeshall, South Walled Garden	HY 4876016	Walled Garden
Graemeshall, Statue	HY 4876016	Statue
Graemeshall, Statue	HY 4876016	Statue
Graemeshall, Statue	HY 4876016	Statue
Heathery Howes	HY48000680	About 200m WSW of cairn HY40NE 20 (OR 2342), is a green mound in the heather, 7.5m in diameter and 0.7m high, mutilated by rabbits. Possibly a boundary marker. OS 21 May 1973.
Holm, St Mary's, Holm Playing Field	HY 483 013	No Class (event)
Howequoy Head	HY46490082	A single light anti-aircraft gun emplacement.
Ilsenstein (Wreck)	ND481 998	Sunk in 1940. Steel singlesteamer.
Italian Chapel	HY48830063	Constructed by Italian prisoners-of-war housed on Lamb Holm whilst assisting in the building of the Churchill Causeways.
Italian Chapel Memorial	HY48760059	Located beside the approach to the Italian Chapel. Statue of George and Dragon, on pedestal, dated 7-8-1943.
Lamb Holm Battery	HY48670016	Part of the World War II defences of Holm Sound approach to Scapa Flow.
Lamb Holm Monorail	HY49020049	Monorail relic of extensive wartime activities on Lamb Holm.
Lapland (Wreck)	ND473 985	Sunk 1915. Steel single-screw steamer.
Lorne (Wreck)	ND479 952	Sunk in 1915. Iron single-screw steamer.
Lycin (Wreck)	ND482 999	Sunk in 1940. Steel single-screw motorship. It lies against N. end of No 2 Barrier
Martis (Wreck)	ND472 983	Sunk 1940. Steelsingle-screw steamer.
Minieh (Wreck)	HY482 007	Sunk 1915. Iron single-screw steamer.
Minieh: Kirk Sound, Scapa Flow, Orkney (Wreck)	HY4838900734	The iron single-screw steamship MINEH was built in 1876 and sunk as a blockship.
Northfield	ND48839881	Excavated Neolithic multi chambered burial mound.
Numidian Kirk Sound, Scapa Flow, Orkney (Wreck)	HY48320 01119	Steel single-screw steamship, built in 1891, and sunk as a blockship in Kirk Sound
Obstruction	HY 4818 0068	Craft, Obstruction
Redstone; Kirk Sound, Scapa Flow, Orkney (Wreck)	HY 4813700908	This a steel single-screw steamship, built in 1918, which was sunk as a blockship
Reginald (Wreck)	ND474 984	Sunk 1915. Iron three masted motor schooner.
Rheinfeld (Wreck)	ND481 997	Sunk 1914. Steel single-screw steamer.
Rosewood (Wreck)	HY478 002	Sunk 1915. Steel single-screw steamer.
Ruby (Wreck)	HY48 00	A Royal Navy Drifter, it was wrecked in a gale on 5/10/1942 near Lamb Holm
St Marys Howequoy Battery	HY46350127	The remains of two earth banked gun-emplacements, a command and control bunker.
St Mary's, Fishery	HY 4858 0138	Fishing Station

Site Name	NGR	Description
St Marys, RAF Balloon Barrage base	HY47680182	An enclosed area extending 650m S to N from St Mary's is situated to the W of West Greaves Road. The area enclosed several WW II military structures.
St Mary's, Rockworks Blockyard, Work Camp	HY 4813801346	Military Camp (20th Century)
St Mary's, Storehouse	HY772301336	Storehouse, Granary(17th Century)
St. Marys Road Camp	HY47330141	A small Nissen hutted camp has been identified from RAF WW II vertical air photographs.
St. Marys Rockworks Blockyard, Work Camp	HY48130134	Admiralty construction camp at the N end of Churchill Barrier No.1 in an area now occupied by the Commodore Hotel and self-catering bungalows. Traces of the roadways between the huts are visible in the northern part of the site.
Tabarka (Wreck)	ND471 985	Sunk 1915. Iron single-screw steamer.
Teeswood (Wreck)	ND482 998	Sunk 1914. Only engines remain.
Thames (Wreck)	HY425 007	Sunk 1914. Steel single-screw steamer.
Thames, Kirk Sound, Scapa Flow, Orkney (Wreck)	HY 4804600828	The steel single-screw steamship was built in 1887 and sunk as a blockship. The stern was removed later and the hull cut down
The Ruff	ND45379665	A single cairn thought to be a burial monument.
Tinker : Glimpsholm Skerry, Holm Sound, North Sea	ND 483 995	19th Century craft.
Token (Wreck)	ND47 99	Was grounded and wrecked in Skerry Sound on 23/12/1941
Unknown: Glimpsholm Skerry, Holm Sound, North Sea	ND 4811 9961	Reported as remains of a blockship sunk in 1914
Weddel Point	ND47919867	Circa. 1960, a grave was partly exposed in the area of the shoreline.

2.3 Water Environment

A search was undertaken to identify baseline information concerning the water quality and water resources in the study area. This included a search for surface water quality and groundwater quality information contained on the Scottish Environment Protection Agency (SEPA) website.

2.3.1 Water Quality

The Churchill Barriers are located within the coastal waters of Scapa Flow. St. Mary's Bay is located immediately to the north and west of the Barriers, whilst Holm Sound is located to the east.

Ordnance Survey (OS) and SEPA mapping shows there are no fluvial watercourses on Glimps Holm or Lamb Holm islands. The nearest watercourse is Graemeshall Burn, located approximately 2km to the north of the barrier on Mainland, which discharges into Holm Sound at Graemeshall. The Loch of Graemeshall is also located at Graemeshall and is connected to Holm Sound through a narrow channel to the east of the village. The Loch of Ayre is located at St Mary's, approximately 1km to the north west of the barrier and is connected to the Bay of St Mary's through a narrow channel to the south west of the village.

The SEPA website provides water quality information for coastal waters in Orkney and indicates that coastal water quality in the area is generally very good. The coastal waters immediately adjacent to Churchill Barrier No. 2 form part of the Scapa Flow waterbody. The water quality of this waterbody has been assessed under the Water Framework Directive (WFD), which requires that all inland and coastal waterbodies reach obtain 'good ecological and chemical status' by 2015. The Scapa Flow waterbody (WFD identifier code: 200474) is assessed as having an overall status of 'Good', with an ecological status of 'Good' and a chemical status of 'Pass'. The target for this

waterbody is to remain at 'Good' status under future WFD reviews to 2027. Several pressures have been identified for the waterbody, which could affect it achieving this target; these include point source pollution as a result of sewage disposal.

The Loch of Ayre has also been assessed under the WFD and is classified as having an overall status of 'High', with an ecological status of 'High' and a chemical status of 'Pass'. It has a target of retaining High status under future WFD reviews and no pressures have been identified.

Ballast Water Management

Orkney Island Council Marine Service operates a Ballast Water Management (BWM) policy on the control and management of ships' ballast water; to provide protection for the important marine environment and the rich natural marine biodiversity within Scapa Flow. The policy applies to all vessels over 400 gt within or using Scapa Flow Harbour Area. The policy has been put in place in order to minimise the potential for pollution resulting from oil, chemical, heavy metals and transfer of non-native aquatic organisms and pathogens which may be contained within ships ballast water and associated sediments[7]. Before this policy was approved, a Habitats Regulations Appraisal (HRA) was undertaken by Intertek (2013)[8] to assess the potential impacts on European sites as a result of implementing the BWM policy. This appraisal concluded that the Proposed BWM Policy (which was later adopted in April 2014) will have no adverse impact on the integrity of any European Sites.

2.3.2 Groundwater

Glimps Holm and Lamb Holm islands are not designated under the WFD as groundwater waterbodies. However, both Burray and Mainland are groundwater waterbodies. Burray (South Ronaldsay) is classified as having an overall status of 'Good' with high confidence, and has been given the target of maintaining this status under future reviews of the WFD to 2027. Mainland (Orkney) is also classified as having a 'Good' overall status with high confidence and has been set the target of maintaining this status.

Both groundwater waterbodies are also classified under the Drinking Water Directive as a drinking water protection zone with a current condition of 'Pass'.

2.3.3 Bathing water quality

The coastal waters around Glimps Holm and Lamb Holm, and in the wider region around Scapa Flow and Holm Sound, have not been designated as bathing waters under the Bathing Waters Directive.

2.3.4 Water resources

The Envirocheck® Report indicates that there are two discharges consents within 1km of the barrier. Both are located approximately 950m north east of the barriers and permit the discharge of sewage effluent from a septic tank or soakaway to groundwater.

2.4 Hydrodynamics and Bathymetry

The Orkney Islands experience two high tides and two low tides per day i.e. the tide is semi-diurnal, with a tidal range at Burray Ness of 3.2 metres. Tidal flows are the main driving factor of the hydrodynamics around the barriers. Currently, tidal flows propagate through the southern Orkney Islands and Scapa Flow, but prior to construction of the barriers, flows through Holm Sound (west of Churchill Barriers 1, 2 and 3) also occurred.

Peak water level occurs firstly on the western side of the barriers (1.5m), and then on the eastern side (1.3m) following a two hour delay. During peak water levels on the eastern side of the barriers, the water level difference across both Barriers 1 and 2 is 0.23m. During peak water levels on the western side of the barriers, the water level difference across both barriers is 0.89m. The maximum water level difference occurs three hours before the time of peak water level west of the barriers with a difference of approximately 1.1m.

[7] OIC Marine Service (2015) Ballast Water Management http://www.orkneyharbours.com/ballast_water_management.asp

8 Intertek (2013) Proposed ballast Water Management Plan Habitats Regulations Appraisal Appropriate Assessment. http://www.orkneyharbours.com/pdfs/bwm/hra_aa_september_2013.pdf.

Local sediments are subject to transport processes including bed erosion and accretion, suspension and transport. Sediment transport is closely linked to the hydrodynamics through the domain, particularly flow velocities and turbulence. Figure 2-2 below shows bathymetry with the Barriers in place and pre-construction. Figures have been taken from HR Wallingford (2002)[9];

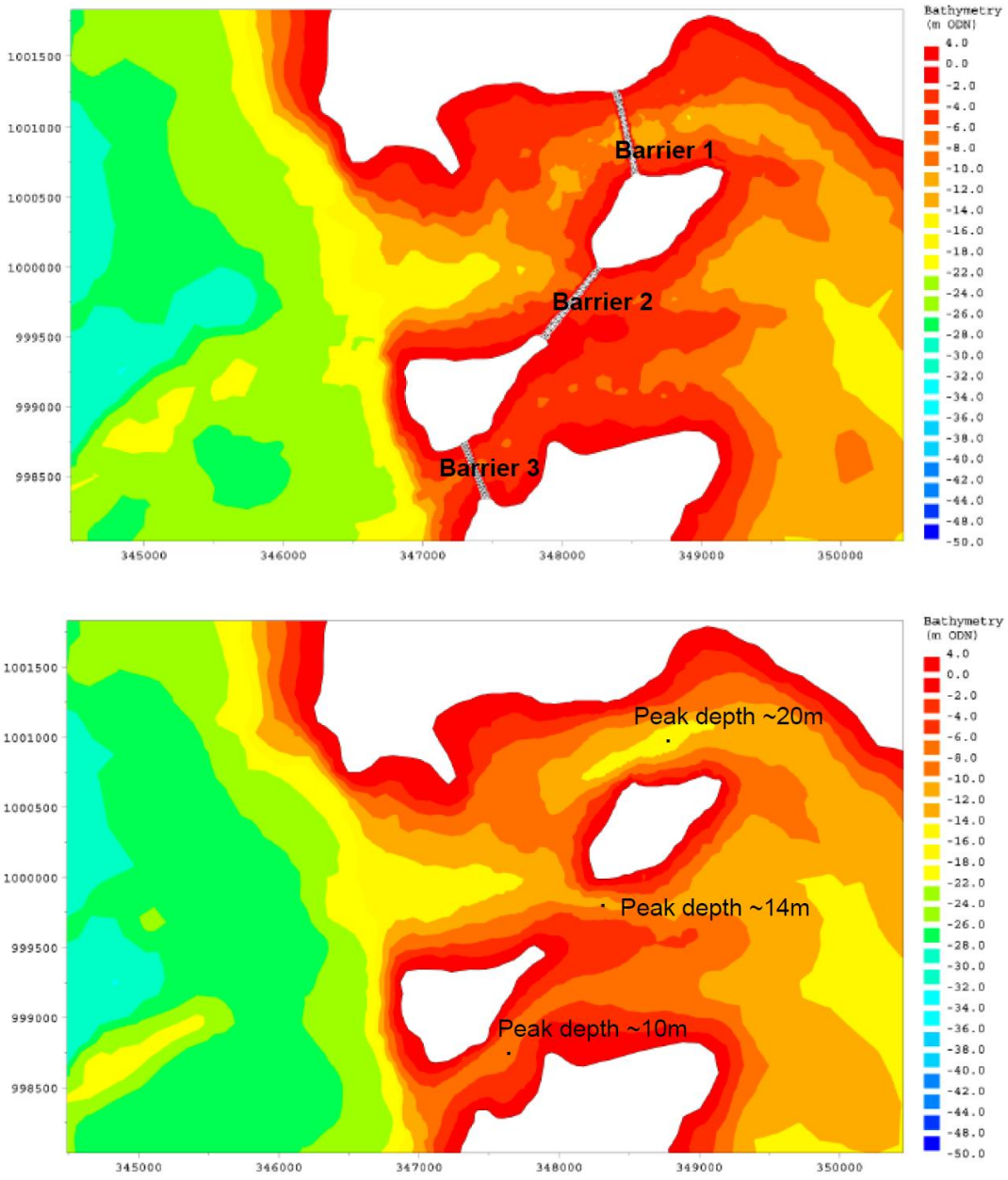

Figure 2-2: Post (above) and Pre-construction (below) Bathymetry.

[9] HR Wallingford; Report EX 5014 (Rev 2.0), Scapa Flow 2D model investigation into the effect of opening the Churchill Barriers on tidal flows, August 2004

2.5 Landscape and Visual Amenity

2.5.1 Landscape character areas

SNH initiated a National Programme of Landscape Character Assessments in 1994, which divided Scotland into 30 Landscape Character Areas (LCA). The study area falls within the Orkney LCA (ref: 100)[10].

'...improvements may be essential for communications, road safety and congestion, there is the possibility that certain road modifications could detract from the local character through the removal of landscape features such as walls, or through the increased traffic flows. Often tarmac carriageway has been widened at the expense of the verge, creating dangerous conditions for walkers and some loss of habitat. Roads through prehistoric landscapes and those appreciated for scenic drives, would require special consideration in the nature of 'improvements' made.'

Glimps Holm and Lamb Holm, as well as the areas of Burray and Mainland that the barriers adjoin, have been given the Holms Landscape Character Type (LCT) within the Orkney LCA. The key characteristics of this LCT are identified as:

- Small uninhabited oval shaped islands;
- Smooth domed topography;
- Wavecut platforms and occasional low cliffs;
- Rough grassland with occasional heath cover;
- Prized gems of near perfect prehistoric landscape;
- Occasional ruined croft or fishing station;
- Occasional beacon or wartime defence structure;
- Frequently grazed by sheep; and
- Valuable for sites of wildlife, seals and, in particular, a variety of seabirds.'

Landscape sensitivities recorded in the assessment for this LCT are:

- Discontinuation of grazing could prejudice the long established agricultural character of certain holms, i.e. the pasture islands;
- Grazing levels possibly threatening important wildlife or archaeological sites; and
- Holms may be potential sites for new development.

Conservation guidelines for this LCT are:

- Encourage continuation of established grazing use of 'pasture island' holms.
- Encourage use of grazing levels which allow conservation of wildlife and archaeological interest.
- Apply strict standards to siting and design of buildings to minimise visual impact and to establish a sympathetic relationship with other buildings or structures.

Further information on the key landscape characteristics of Glimps Holm and Lamb Holm is provided within the Burray Island Character Area. It identifies several contemporary features of cultural heritage value including the Churchill Barriers and highlights the landscape importance of views of the Italian Chapel on Lamb Holm.

2.5.2 Landscape designations

There are no statutory or non-statutory landscape designations in, or in close proximity to, the Churchill Barriers. The closest designated site is the Hoy and West Mainland National Scenic Area (NSA), which is located approximately 17km to the west of Barriers 1 and 2. There are 40 NSAs in Scotland, which have been chosen as they represent Scotland's finest landscape areas.

However, there are a number of designated sites that provide an important contribution to the landscape and visual amenity of the area and where landscape considerations form an important

[10] Scottish Natural Heritage (1998), Orkney Landscape Character Assessment http://www.snh.org.uk/pdfs/publications/review/100.pdf

aspect of their designation and/or setting. Key landscape designations that could be affected by changes to the barrier include:

- Lamb Holm Settlement scheduled monument
- Loch of Ayre Broch scheduled monument
- The Italian Chapel listed building
- Other listed buildings in St Mary's (see Figure 2-1)

2.5.3 Potential landscape and visual receptors

Physical modifications to the barrier have the potential to affect a range of sensitive landscape and visual receptors. Landscape impacts relate to the effects of any changes on the physical characteristics of the landscape and its resulting character and quality. Visual impacts relate to the effects on views experienced by visual receptors (e.g. residents, footpath users, tourists, etc) and on the visual amenity experienced by those people.

Potential sensitive receptors that could be affected by changes to the barrier include:

- Road receptors
- A961
- B9052
- Recreational Routes
- Core Path B9 along the beach on eastern side of Glimps Holm
- Core Path B8 at the north west corner of Burray
- Core Path H1 west of St Mary's (Mainland)
- Core Path H3 at East Breckan (Mainland)
- Residential Receptors
- Holm/St Marys
- Farmsteads near Northtown
- Farmsteads near Cornquoy
- Other
- Lamb Holm Island Pier
- St Marys Pier

2.6 Contaminated land

A search was undertaken to identify baseline information concerning the potential for contaminated land in the study area. This included a search for information on authorised and historic landfill sites contained on the SEPA website and within an Envirocheck® Report, which used a 1km radius search area.

There are no recorded authorised or historic landfill sites, or other waste management facilities within close proximity to the barrier. The closest such sites are located approximately 6km to the north near Kirkwall Airport on Mainland[11].

The Envirocheck® Report indicates that there is one (active) registered Explosive Site in the study area. In it located at Holme Jetty on Lamb Holm, approximately 600m south-west from Barrier 1 at its closest and 200m north-west from the Churchill Barrier 2 at its closest point.

2.7 Population and Local Community

2.7.1 Population

Lamb's Holm and Glimps Holm are both uninhabited, however there are a number of small settlements in close proximity to the barriers, most notably St. Mary's which is located approximately 2km north of the barriers on the East Mainland of Orkney. It was originally a small fishing port but

[11] Scottish Environment Protection Agency (SEPA), Closed landfill map http://www.sepa.org.uk/waste/waste_infrastructure_maps.aspx

now also operates a number of businesses focussed on tourism including wildlife tours, dive tours and sports activities such as kayaking. This settlement is the site of several historical features, including several listed buildings and a scheduled monument.

2.7.2 Public Rights of Way / Cycle Routes

There are several public rights of way in the study area. Core Paths are identified in the Orkney Core Paths Plan[12] and represent a network of public routes designed to provide local residents and visitors with good access to the outdoors

OS mapping indicates that the Churchill Barriers 1 and 2, together with the other Churchill Barriers, form part of an established long-distance footpath connecting Kirkwall to the north with Burray Village to the south.

2.7.3 Traffic and Transport

The A691 crosses the Churchill Barriers and is the only route for road traffic using the Gills Bay to St Margarets Hope ferry service to reach the Orkney mainland. It is also the only route for the population of South Ronaldsay and Burray to reach the Orkney mainland, making extended periods of road closure unacceptable.

[12] Orkney Islands Council (2009), Orkney Core Paths Plan http://www.orkney.gov.uk/Files/Planning/Outdoor-Access/Core-Paths-Plan/Core_Paths_Plan.pdf

3 Project options

The five options below have been put forward for further consideration based on a review of the initial proposed options for the barriers. The following section provides a high-level appraisal of the potential risks and benefits on environmental factors, identified in Chapter 2 above, to inform the development of these revised options.

- 1: Re-facing Barrier 2 to be optimised as a wave overtopping solution with energy capture at Barrier 1 and/or 2.
- 2: Remove section of Barrier and replace with bridge and free flow turbines for energy capture at Barrier 1 and/or 2.
- 3: Remove section of Barrier and replace with structure for vertical axis turbines for energy capture at Barrier 1 and/or 2.
- 4: Remove section of Barrier and replace with structure for horizontal axis turbines for energy capture at Barrier 1 and/or 2.
- 5: Beach recharge at Barrier 2 with energy capture at Barrier 1 only.

4 Impact appraisal

This section provides a summary of the key potential environmental impacts associated with each of the project options. It uses the information gathered during the desk study exercise and assesses whether each option has the potential to cause a significant environmental impact on the sensitive environmental features of the study area. Both positive and negative potential impacts are identified. Table 8 details the possible impacts of each option on environmental aspects and notable features as identified in the baseline review. Of note Options 2 to 4, and 5b, involve the deployment of energy capture solutions as part of the design options.

4.1 Options Impacts Appraisal Table

Table 4-1 below details the potential impacts of each of the revised options on environmental aspects/ notable features as identified within the baseline review (Chapter 2). A summary of the impacts is given in Table 14-3.

Table 4-1: Options Impact Appraisal

Environmental Aspect	Notable feature	Option1 – Re-facing Barrier 2 and Energy Capture at 1 or 2	Option 2 - Remove Section of Barrier and replace with bridge and free flow turbines at 1 or 2	Option 3 - Remove Section of Barrier and replace with structure for vertical axis turbines at 1 or 2	Option 4 - Remove Section of Barrier and replace with structure for horizontal axis turbines at 1 or 2	Option 5a - Beach recharge at Barrier 2	Option 5b - Beach recharge at Barrier 2 with energy capture at Barrier 1
Biodiversity and nature conservation	**Designated sites**	No impacts identified. One designated site falls within 10km of the barriers (Copinsay SPA, which is located approximately 8.8km and 9.2km to the East of Barrier 1 and Barrier 2). This site is considered sufficiently distant from the works for any likely adverse impacts to the designated species and qualifying features of the site. Glimps Holm Island LWS, located at the southern end of the Barrier 2 supports nationally important habitats (maritime cliffs and slopes and coastal sand dunes) and colonies of Arctic Tern and Common Gull, which may be impacted by construction works to Barrier 2 under Options 1-4. Consultation with SNH and the local council would be recommended prior to works in relation to potential impacts on this site.				Glimps Holm Island LWS, located at the southern end of the Barrier 2 may be impacted by beach re-charge. There is the potential for both positive impacts and negative impacts on the LWS, with adverse impacts likely in the short term as a result of deposition of beach material at the site. However positive impacts may arise in the long term by providing more beach habitat within the LWS, which may provide ecological value for protected species, including more breeding habitat for terns. Consultation with SNH and the local council would be recommended prior to works in relation to potential impacts on this site.	
	Habitats	Works to the barriers could result in the temporary loss of or damage to sensitive marine and terrestrial habitats present on the barrier and on the surrounding seabed, including Coastal Vegetated Shingle, a BAP habitat	Construction of the bridge structure and associated tidal energy capture structures could result in the permanent loss of or damage to sensitive marine and terrestrial habitats present on the barrier and on the surrounding seabed, including Coastal Vegetated Shingle, a BAP habitat	Construction of tidal energy structures within the barriers could result in the permanent loss of or damage to sensitive marine and terrestrial habitats present on the barrier and on the surrounding seabed, including Coastal Vegetated Shingle, a BAP habitat. The works will involve removal of sections of the barriers to install the turbine structures.		Beach recharge could adversely affect sensitive coastal habitats present on the affected beach area. Conversely, such works could provide new valuable beach habitat which is of ecological values for a range of flora and fauna, including terns.	
							Construction of tidal energy structures within Barrier 1 could result in the permanent loss of or damage to sensitive marine and terrestrial habitats. However, the provision of new available habitat at Barrier 2 is likely to reduce the significance of this impact in the longer term.
	Terrestrial species (including birds)	Construction works to the barrier structure could have a temporary adverse effect on Otter using the barrier for commuting, resting or feeding activity and bird species foraging in the area. This is due to potential disturbance (noise and visual) by construction activities or through impacts on marine water quality through the release of contaminating materials and sediment.	Construction of the bridge could have a temporary adverse effect on otter using the barrier for commuting, resting or feeding activity and bird species foraging in the area. This is due to potential disturbance (noise and visual) by construction activities or through impacts on marine water quality through the release of contaminating materials and sediment. Long term impacts on Otter are likely as a result of the proposal for energy capture as turbines pose a collision risk to this species, as well as diving birds. The new bridge structure may not be as suitable for otter and therefore the habitat value of the area could be adversely affected.	Construction of tidal energy structures within the barriers could have a temporary adverse effect on Otter using the barrier for commuting, resting or feeding activity and bird species foraging in the area. This is due to potential disturbance (noise and visual) by construction activities or through impacts on marine water quality through the release of contaminating materials and sediment. Long term impacts on terrestrial fauna and birds (particularly diving birds) are likely as a result of the installation of turbines in the barriers. Both turbine designs pose collision risk for these species as currents may draw animals into the rotor sweep. If mitigation is not put in place to prevent animals coming into contact with the blades there is the potential for a major adverse impact from the structure. However, if mitigation is in place these options are likely to be of slight adverse impact		Beach recharge and widening could affect bird species and other animals and plants using the affected beach area. Arctic Tern and Common Gull colonies reside in Glimps Holm LWS which could be adversely impacted during the deposition works, particularly during breeding where these species are more sensitive to disturbance. However, provision of new beach habitat could benefit a range of species, however, which promotes longer term benefits from this option.	
							Construction of tidal energy structures within the Barrier 1 could have a temporary adverse effect on Otter using the barrier for commuting, resting or feeding activity and bird species foraging in the area. This is due to potential disturbance (noise and visual) by construction activities or through impacts on marine water quality through the release of contaminating materials and sediment. Long term impacts on terrestrial fauna and birds (particularly diving birds) are likely as a result of the installation of turbines in Barrier 1, in terms of collision risk. However, if mitigation is in place these options are likely to be of slight adverse impact.

Environmental Aspect	Notable feature	Option1 – Re-facing Barrier 2 and Energy Capture at 1 or 2	Option 2 - Remove Section of Barrier and replace with bridge and free flow turbines at 1 or 2	Option 3 - Remove Section of Barrier and replace with structure for vertical axis turbines at 1 or 2	Option 4 - Remove Section of Barrier and replace with structure for horizontal axis turbines at 1 or 2	Option 5a - Beach recharge at Barrier 2	Option 5b - Beach recharge at Barrier 2 with energy capture at Barrier 1
		Construction best practice and seasonal constraints would need to be applied during construction to avoid a significant negative effect on the protected species					
	Marine species	Construction works to the barrier structure could adversely impact upon marine mammal and fish species present in the area due to disturbance (noise) by construction activities or through impacts on marine water quality through the release of contaminating materials and sediment.	Construction works could impact upon marine mammal and fish species present in the area due to disturbance (noise and vibration) by construction activities or through impacts on marine water quality through the release of contaminating materials and sediment. The provision of the bridge structure, which would allow water passage through the barrier between Holm Sound and Scapa Flow could benefit fish and mammal movement through the area. However, installation of turbines pose a collision risk to these species which would constitute a major adverse impact if mitigation is not put in place to safeguard marine species.	Operation of the tidal energy structures could result in the disturbance, damage or death of marine fish and mammals that travel too close to the turbines; however, mitigation measures could be employed to reduce long term adverse impact on these fauna.		Recharge may cause direct mortality to sessile organisms by burying them in the new material, whilst seafloor habitats in the area have the potential to be adversely affected. Provision of new beach habitat could benefit a range of species. Potential adverse impacts may arise if the recharge material is contaminated with pollutants or invasive non-native species.	Operation of the tidal energy structures in Barrier 1 could result in the disturbance, damage or death of marine fish and mammals that travel too close to the turbines; however, mitigation measures could be employed to reduce long term adverse impact on these fauna.
		Construction best practice and seasonal constraints would need to be applied during construction to avoid a significant negative effect on the protected species					
Historic environment	**Scheduled monuments**	Temporary adverse effects on the setting of several scheduled monuments present in the vicinity of the barrier, most notably Lamb Holm Settlement, could occur during the construction phase due to a range of construction activities. Permanent adverse effects are not likely, provided the re-facing of the barrier occupies a similar footprint to the structure already in situ, particularly in the height.	Permanent adverse effects could occur if the new bridge structure comprises a significantly larger structure to the barrier or is located on a different alignment.	Permanent adverse effects are unlikely. However, if the installation of tidal energy structures comprises a significantly larger structure to the barrier or is located on a different alignment.		No adverse impacts on scheduled monuments are expected.	Temporary adverse effects on the setting of several scheduled monuments present in the vicinity of the barrier, most notably Lamb Holm Settlement, could occur during the construction of the turbines within Barrier 1. Permanent adverse effects are unlikely. However, if the installation of tidal energy structures comprises a significantly larger structure to Barrier 1 or is located on a different alignment.
	Listed buildings	Temporary adverse effects on the setting of several listed buildings present in the vicinity of the barriers could occur during the construction phase due to a range of construction activities. Permanent adverse effects are not likely, provided the re-facing of the barrier occupies a similar footprint to the structure already in situ, particularly in the height.	Permanent adverse effects could occur if the new bridge structure comprises a significantly larger structure to the barrier or is located on a different alignment.	Permanent adverse effects are unlikely. However, if the new tidal energy structures comprises a significantly larger structure to the barrier or is located on a different alignment.		No adverse impacts on scheduled monuments are expected.	Permanent adverse effects are unlikely. However, if the new tidal energy structures comprises a significantly larger structure to Barrier 1 or is located on a different alignment.
	Heritage features and archaeology	Construction works to the barrier structure could result in damage to the barriers, which are a local heritage feature. There are also the remains of a large number of heritage features in close proximity to the barrier, which could be adversely affected by its construction. Construction best practice would need to be applied to avoid	The construction of the bridge could result in the loss of, or damage to, the barriers, which are local heritage features. There are also the remains of a large number of heritage features in close proximity to the barrier, which could be adversely affected by its construction. There are a number of wreck sites in the area that could be adversely affected during the construction phase or by the	The construction of the tidal energy component will result in removal of sections of the barriers, which are local heritage features. There are also the remains of a large number of heritage features in close proximity to the barrier, which could be adversely affected by its construction, particularly Burray Ferry (wreck) and Lycia (wreck)which lie very close to or adjacent to Barrier 2.		No adverse impacts on Barrier 2 are likely as a result of beach re-charge.	The construction of the tidal energy component will result in removal of sections of Barrier 1 which is a local heritage feature. There are also the remains of a large number of heritage features in close proximity to the Barrier 1 which could be adversely affected.
						Burray Ferry (wreck) and Lycia (wreck) lie very close to or adjacent to Barrier 2 and will be impacted by beach-recharge. Furthermore, several other wreck sites are located within 500m of Barrier 2 and may be	

Environmental Aspect	Notable feature	Option1 – Re-facing Barrier 2 and Energy Capture at 1 or 2	Option 2 - Remove Section of Barrier and replace with bridge and free flow turbines at 1 or 2	Option 3 - Remove Section of Barrier and replace with structure for vertical axis turbines at 1 or 2	Option 4 - Remove Section of Barrier and replace with structure for horizontal axis turbines at 1 or 2	Option 5a - Beach recharge at Barrier 2	Option 5b - Beach recharge at Barrier 2 with energy capture at Barrier 1
		significant adverse effect.	resulting change in water flow by opening up the barrier.			submerged and/ or damaged by the recharge material.	
		Construction and excavation work may offer the opportunity to record known and unknown heritage features and archaeological remains.				Potential impacts on wreck sites within proximity to the barrier may occur as a result of the beach re-charge.	Construction and excavation work may offer the opportunity to record known and unknown heritage features and archaeological remains.
Landscape, townscape and visual amenity	**Local landscape character and visual amenity**	Construction works to the barrier structure could result in damage to the barrier, which is a local landscape feature. This could affect the local landscape character and visual amenity and impact upon a number of important views of the barrier and surrounding area.	The construction of the bridge could result in the loss of, or damage to, the barrier, which is a local landscape feature. This could affect the local landscape character and visual amenity and impact upon a number of important views of the barrier and surrounding area. The new bridge could have a permanent positive or negative effect on local landscape character and visual amenity depending upon the design that is implemented.	The construction of the tidal energy component will result in loss of sections of the barriers, which are local landscape features. This could affect the local landscape character and visual amenity and impact upon a number of important views of the barrier and surrounding area. The design of the new barrier could also have an adverse effect on local landscape character and visual amenity if a sensitive and appropriate design is not implemented.		Beach recharge and widening could change the local landscape character. This could have positive effects on the landscape, which would depend upon whether the works enhance or adversely impact upon the character of the area affected.	The construction of the tidal energy in Barrier 1 will result in loss of sections of the barrier, which are local landscape features. This could affect the local landscape character and visual amenity and impact upon a number of important views of the barrier and surrounding area. The design of the new barrier could also have an adverse effect on local landscape character and visual amenity if a sensitive and appropriate design is not implemented. However, beach re-charge could improve the landscape character of the area, which may offset potential adverse impacts from Barrier 1, if it is considered that be-recharge has positive landscape impacts.
	Landscape designations	There are no statutory or non-statutory landscape designations in close proximity to the barrier. However, there are numerous key landscape features in the area including scheduled monuments and listed buildings within close proximity to the barriers. The condition and setting of these features could be affected temporarily, during the construction phase, or permanently if the re-faced barrier and bridges are not of an appropriate design standard or occupy a significantly larger footprint, both vertically and horizontally than the current structures in-situ.				The condition and setting of landscape features are unlikely to be impacted by this option.	The condition and setting scheduled monuments and listed buildings could be affected temporarily, during the construction phase, or permanently if the energy solution in Barrier 1 occupies a significantly larger footprint, both vertically and horizontally than the current Barrier.
Water quality and water resources	**Surface water quality**	The ecological and chemical quality of Scapa Flow and Holm Sound could be adversely affected during the construction phase due to the release of contaminating materials and sediment. Pollution Prevention Guidelines (PPG) should be followed during the works to ensure that adverse impacts on the water quality are limited. No significant permanent adverse impacts on water quality are anticipated; however, as a result of opening the barriers sediment movement may have localised impacts on the water quality, such as increased turbidity, which may have negative impacts on marine fauna within the area. This is likely to be temporary in nature whilst the mobilised sediments settle.				No impacts identified as a result of beach re-charge at Barrier 2, provided material for recharge is clean of pollutants and invasive non-native species.	The ecological and chemical quality of Scapa Flow and Holm Sound could be adversely affected during the construction phase due to the release of contaminating materials and sediment. Pollution Prevention Guidelines (PPG) should be followed during the works to ensure that adverse impacts on the water quality are limited. No significant permanent impacts on water quality are anticipated; however, as a result of opening the barriers sediment movement may have localised impacts on the water quality such as temporary increased turbidity which may have impacts on marine fauna within the area.

Environmental Aspect	Notable feature	Option1 – Re-facing Barrier 2 and Energy Capture at 1 or 2	Option 2 - Remove Section of Barrier and replace with bridge and free flow turbines at 1 or 2	Option 3 - Remove Section of Barrier and replace with structure for vertical axis turbines at 1 or 2	Option 4 - Remove Section of Barrier and replace with structure for horizontal axis turbines at 1 or 2	Option 5a - Beach recharge at Barrier 2	Option 5b - Beach recharge at Barrier 2 with energy capture at Barrier 1
	Groundwater quality	No impacts identified.					
Contaminated land		There is a small risk that activities on Barrier 2 during all Options could affect the Explosive Site at Holme Jetty on Lamb Holm.					
Recreation and amenity		Temporary impacts on recreation are likely to occur during the construction phase due to closure of the barrier affecting transport movements in the area and construction activities limiting recreational opportunities in close proximity to the works area. Improved transport links across the area could have a benefit to recreational activities.				Increased beach habitat as a result of this option may improve recreational facilities in the area. Furthermore, the increase beach habitat could be of ecological value for protected species, which also promotes potential educational opportunities.	
		Potential localised adverse impacts on recreational diving and fishing may arise through opening the barriers as a result of increased sediment movement which may increase the turbidity of the water in Scapa Flow and around the barriers. These impacts are unlikely to be significant in the long term, as the mobilised sediment is likely to settle, thus restoring natural conditions. Opening sections or the entirety of the barriers may also result in more treacherous diving conditions due to unrestricted or less restricted flow within the vicinity of the barriers.					
Traffic and transport / Public Rights of Way		Temporary impacts on the highway network are likely to occur during the construction phases due to closure of the barrier affecting transport movements in the area. Improved transport links across the area would provide a significant benefit to the highway network. Furthermore, flood protection works to the barriers should reduce the numbers of road closures due to adverse weather which denotes a positive impact on transport as a result of the works.					
Air quality		No significant adverse impacts identified; however, there is the potential for temporary localised impacts on air quality during the construction works, due to plant emissions for example.					
Population		Temporary impacts on local residents and visitors are likely to occur during the construction phase due to closure of the barrier affecting transport movements in the area and construction activities limiting recreational opportunities in close proximity to the works area. Improved transport links across the area could have a benefit to local people by improving access through the area	Provision of a renewable energy component could provide new job opportunities for local residents in terms of servicing and maintaining the equipment. Furthermore, generation of renewable energy could generate additional income for the local economy. In addition the generation of renewable energy will reduce the dependency on non-green sources of energy which will have wider reaching benefits. Temporary impacts on local residents and visitors are likely to occur during the construction phase due to closure of the barrier affecting transport movements in the area and construction activities limiting recreational opportunities in close proximity to the works area. Improved transport links across the area could have a benefit to local people by improving access through the area.			Provision of a renewable energy component could provide new job opportunities for local residents in terms of servicing and maintaining the equipment. Furthermore, generation of renewable energy could generate additional income for the local economy. In addition the generation of renewable energy will reduce the dependency on non-green sources of energy which will have wider reaching benefits. Temporary impacts on local residents and visitors are likely to occur during the construction phase due to closure of the barrier affecting transport movements in the area and construction activities limiting recreational opportunities in close proximity to the works area. Improved transport links across the area could have a benefit to local people by improving access through the area

4.2 Impact Appraisal Summary Table

The assessment has identified a range of potential positive and negative effects associated with the five options. These potential impacts, magnitude and their likely significance are summarised in Table 4-3 using the following symbology (Table 4-2). Uncertainties of impacts have arisen whereby the impacts are best placed to be assessed once designs have been finalised. Symbols in brackets highlight the range of potential impact significances of each option where the overall impact has been assessed as uncertain. (For example the symbol **? (+ / -)** suggests that there is the potential for a positive impact or a negative impact, however this is uncertain at this stage until options have been developed further.)

Table 4-2: Impact scoring categories

Impact significance	Impact symbol
Likely to be a very positive impact	**++**
Likely to be a positive impact	**+**
Likely to be a neutral impact	**0**
Likely to be a negative impact	**-**
Likely to be a very negative impact	**--**
Impact not known/unclear	**?**

Table 4-3: Impact summary table

Environmental Aspect	Notable feature	Option1 – Re-facing Barrier 2 and Energy Capture at 1 or 2	Option 2 - Remove Section of Barrier and replace with bridge and free flow turbines at 1 or 2	Option 3 - Remove Section of Barrier and replace with structure for vertical axis turbines at 1 or 2	Option 4 - Remove Section of Barrier and replace with structure for horizontal axis turbines at 1 or 2	Option 5a - Beach recharge at Barrier 2	Option 5b - Beach recharge at Barrier 2 with energy capture at Barrier 1
Biodiversity and nature conservation	**Designated sites**	0	0	0	0	0	0
	Habitats	-	-	-	-	? (- / +)	? (0 / - / +)
	Terrestrial species	? (0 / -)	? (0 / - / --)	? (0 / - / --)	? (0 / - / --)	? (0 / - / +)	? (0 / - / +)
	Marine species	? (0/-)	? (+ / -)	? (0 / - / --)	? (0 / - / --)	? (0 / - / +)	? (0 / - / +)
Historic environment	**Scheduled Monuments**	? (0 / -)	? (0 / -)	? (0 / -)	? (0 / -)	? (0 / -)	? (0 / -)
	Listed buildings	? (0 / -)	? (0 / -)	? (0 / -)	? (0 / -)	0	? (0 / -)
	Heritage features and archaeology	? (+ / -)	? (+ / -)	? (+ / -)	? (+ / -)	? (0 /-- / -)	? (+ / -/ --)
Landscape, townscape and visual amenity	**Local landscape character and visual amenity**	? (0 / -)	? (0 /- / +)	? (0 / -)	? (0 / -)	? (+ / 0 / -)	? (0 / -)
	Landscape designations	? (0 / -)	? (0 / -)	? (0 / -)	? (0 / -)	? (+ / 0 / -)	? (0 / -)
Water quality and water resources	**Surface water quality**	? (0 / -)	? (0 / -)	? (0 / -)	? (0 / -)	? (0 / -)	? (0 / -)
	Groundwater quality	0	0	0	0	0	0
	Water resources	0	0	0	0	0	0
Contaminated land		? (0 / -)	? (0 / -)	? (0 / -)	? (0 / -)	0	? (0 / -)
Recreation and amenity		? (0 / - / +)	? (0 / - / +)	? (0 / - / +)	? (0 / - / +)	? (0 / - / +)	? (0 / - / +)
Traffic and transport		+	+	+	+	+	+
Air quality		0	0	0	0	0	0
Population		+	+	+	+	+	+

4.3 Discussion

The purpose of this study is to assess the potential environmental impacts of all options at a high level for the purpose of obtaining Planning Permission in Principle for the concept of opening one or both of the Barriers for a tidal energy scheme and to address wave overtopping at Barrier 2.

This appraisal in Section 4.1 and 4.2, above, provides a high-level assessment of the associated potential environmental risks and benefits for each of the broad scale project options. Several uncertainties exist within the above assessment in which potential impacts are dependent upon the location and extent of these works and the existing environment in the areas of work which will be determined once options have been developed further and finalised, during the next stage of detailed design and full planning. Recommendations for further surveys to support a full planning permission application, once the options have been developed further, are contained in Section 5.

4.3.1 Biodiversity and Nature Conservation

No adverse impacts on the internationally designated site Copinsay SPA are anticipated for any of the project options due to the significant distance (c.9km) between the barriers and this site. However, there is the potential for adverse impacts on the Glimps Holm Island LWS as a result of works to Barrier 2 and mitigation measures may be required, guided by advice from consultation with SNH and the local authority. However, there are also potential positive impacts resulting from Option 5 as deposition of beach material may provide more breeding habitat for terns which are noted as an interest feature at Glimps Holm.

Option 2 has the potential to provide positive environmental effects in terms of marine biodiversity and landscape. Bridges would enable fish and marine mammal species to pass across the barriers. Furthermore, a sensitively designed, high-quality bridge could enhance the landscape character and visual amenity of the area. However, renewable energy structures are to be associated with the bridge design which may have negative impacts on protected fauna within the area, which is discussed further in section4.3.6.

Works during construction have the potential to have adverse impacts in terms of unintentional mobilisation and deposition of material within and around the works footprint which has the potential to have an adverse effect on some marine species in the local area. There is also the potential for direct mortality to sessile organisms by burying them in the new material such as rock armour and beach re-charge material, whilst seafloor habitats in the area have the potential to be adversely affected by the works.

In addition, construction activities at the barriers also have the potential to cause disturbance (noise and vibration) which may adversely impact marine fauna and bird life, particularly cetaceans and phocid species and breeding seabirds within the area. Mitigation should be put in place to reduce these impacts, to include timing the works to avoid the bird breeding season and to reduce vibration impacts from machinery, for example using shock absorbers on heavy plant machinery on and around the works area.

Option 5, beach recharge and widening, has the potential to deliver a number of benefits including include the creation of new beach habitat. The potential likelihood and significance of these benefits would depend upon the location and extent of these works and the existing environment in these areas. This option may also present fewer and less significant environmental risks, as it would involve less construction activity and would not damage the existing barrier structure. However, the deposition of material has the potential to have an adverse effect on some marine species in the local area. There is also the potential for direct mortality to sessile organisms by burying them in the new material, whilst seafloor habitats in the area have the potential to be adversely affected.

All options involve opening the barriers to enable energy generation which may alter sedimentation and material movement within the locality of the barrier. Increased sediment movement may increase the turbidity of the water and has the potential to adverse impact on marine fauna. The magnitude of this impact is best placed to be determined once the final options have been developed and the effects can be studied and assessed further.

Mooring options at the Barriers, which would be submitted following design development, will need to consider adverse impacts on marine fauna around the Barrier, including fish and marine mammals. Impacts are best placed to be appraised once options have been developed.

4.3.2 Historic Environment

All of the options have the potential to alter the Churchill Barriers 1 and 2, with all options except Option 5a to involve removal of sections of the existing barriers to facilitate renewable energy capture. This represents an initial constraint to the works as objection to alteration to the barriers from the public and archaeological consultees may significantly limit the scope of works at the barriers, The barriers are local heritage features and may be a valuable habitat for a range of sensitive species, most notably Otter. Damage to the barriers and the development of a new structure either in its place or associated with it, may result in the loss of important heritage remains and reduce the habitat value of the area. Such issues would need to be considered further during the development of the scheme and should be supported with appropriate site surveys.

The works may also have negative impacts on listed buildings and scheduled monuments within close proximity the barriers. Changes to the scenery as viewed from the designated features may have adverse impacts on their designation and sensitive design will be required to take into account these adverse impacts. Lamb Homb Settlement in particular may be adversely impacted by the works to the barriers. Consultation with SNH and Historic Scotland would be required during the design in addition to appropriate visual impact assessments for features that may be impacted.

Several HER wrecks are located in close proximity to both barriers, however, it is likely that any negative impacts on the wreck sites, such as damaging or submerging artefacts, can be significantly reduced or mitigated against if the works avoid areas of these historic assets.

However, Burray Ferry and Lycia wrecks lie in very close proximity to Churchill Barrier 2, thus any works to Churchill Barrier 2 under all options are likely to disturb these sites. Furthermore, beach re-charge is likely to be the most detrimental activity on submerged wreck sites, within close proximity to the barriers, Burray Ferry and Lycia wrecks aside. Deposition of new beach material may submerge and/ or damage other wreck sites within 500m of the barrier. Liaison with Historic Scotland is advised prior to options being finalised.

There may also be positive impacts on heritage and cultural receptors; construction and excavation work may offer the opportunity to record known and unknown heritage features and archaeological remains which will have cultural benefits.

4.3.3 Landscape

All of the options could potentially affect the landscape character and visual amenity of the local area, particularly if a larger structure is put in place or a poor quality or inappropriate design is implemented. This can be mitigated against by sensitive design of the structure and undertaking appropriate labs cape assessments to reduce visual impacts. Beach re-charge may promote positive impacts for landscape quality by increasing this habitat within the locality.

4.3.4 Population, Transport and Recreation

All of the options would have the potential to provide significant positive benefits to the local transport network and the local population, by reducing wave overtopping at the barrier and therefore improving access through the area. This could have secondary benefits in terms of improving access to recreation and amenity. Furthermore, under option 5 the increased area of beach habitat promotes further use for recreational activities within the area and potential educational opportunities. However, there may be public opposition to alterations to the barriers and disruption to traffic flow throughout the works. Furthermore, temporary adverse impacts on population, transport and recreation receptors are likely during the works as potential road closures and access restriction will need to be put in place to facilitate the works under all proposed options, and there is the potential for localised adverse impacts on recreational diving as a result of increased sediment mobilisation from opening the barriers and change in flow. Difficulties in maintaining traffic flow would need to be addressed at design stage to ensure that there is a limited adverse impact on the local population. The overall impact of the scheme, however remains positive in the medium to long term, the magnitude likely to be influence by the finalised option and design at the next stage. Furthermore, recreational use close to the turbine intakes is likely to be restricted due to the hazard the structures present. This may adversely impact the recreational value of the area if significant restrictions are put in place. However, conversely bridge structures may be potentially navigable, but this is depended upon the final design of the proposals at the barrier.

4.3.5 Air Quality

No significant negative impacts of air quality are expected as a result of the works, however there is scope for temporary negative impacts during construction resulting emissions from construction activities.

4.3.6 Water Resources

No significant adverse impacts on water quality is anticipated as a result of the proposed options provided Pollution Prevention Guidelines (PPG) as produced jointly by the Scottish Environment Protection Agency (SEPA), Environment Agency and the Environment and Heritage Service of Northern Ireland are adhered to throughout the works.

There is the potential for slight adverse impacts on local water quality as a result of opening the barriers due to change in sediment movement. This may lead to an increase in water turbidity where the flows are most affected. However, this is likely to be temporary as mobilised sediment settles post-construction.

4.3.7 Contaminated Land

There is a small risk that construction activities, including the deposition of material for beach re-charge at Barrier 2 (Option 5a and b), could affect the Explosive Site at Holme Jetty on Lamb Holm; however, it is considered that impacts of the works on the barriers will be neutral in terms of this environmental aspect provided appropriate mitigation is put in place to safeguard the area.

4.3.8 Tidal Energy Capture

All Options 1 to 5 consider the provision of a tidal energy component in the new structure which presents a number of potential risks to sensitive ecology in the area. Most notably, the energy structure could cause disturbance, damage or death to animals that travel too close to the turbine blades. This could present a significant issue given the important fish and mammal species known to inhabit the area, in addition to diving birds. However, potential mitigation measures could be employed to reduce the potential adverse impact of the new structure. Such mitigation could involve (Wilson et. al, 2007)[13]):

- Raising the visibility/ detection of the turbines to pelagic animals (e.g. use of sonar deterrents, colour/ light deterrents).
- Netting/ grids installed around the turbines.
- Use of fish friendly turbines

The incorporation of tidal energy capture within the design has long term potential benefits for many environmental receptors by reducing the dependency on fossil fuel on Orkney and promoting renewable energy.

[13] Wilson, B. Batty, R. S., Daunt, F. & Carter, C. (2007) Collision risks between marine renewable energy devices and mammals, fish and diving birds. Report to the Scottish Executive. Scottish Association for Marine Science, Oban, Scotland, PA37 1QA.

5 Recommendations

Orkney Islands Council have undertaken a number of studies into the feasibility of measures to reduce overtopping on Churchill Barrier 2 and or the reopening both one and two combined with the opportunity to generate renewable energy. At this stage it is important to understand the environmental impacts and requirements of the planning process. This report supports an application for a formal Screening Opinion. This will support an application for Planning Permission in Principle. From our review of the environmental issues a number of surveys and assessments are required to gain a more detailed understanding of the environmental issues associated with the overall concept of the scheme. The following recommendations have been made in light of the historical interest of the barriers and tidal flow regime which will be impacted by the scheme, in principle.

These surveys and assessments are briefly described below. The full scope of the environmental assessment would need to be agreed in advance through consultation with Orkney Islands Council and other relevant stakeholders including Scottish Natural Heritage (SNH), the Scottish Environmental Protection Agency (SEPA) and Historic Scotland.

At the earliest stages to determine the progression of the scheme, we suggest that:

- A formal screening by Orkney Islands Council and Marine Scotland under The Town and Country Planning (Environmental Impact Assessment) (Scotland) Regulations 2011 to determine the requirement for a statutory Environmental Impact Assessment (EIA) is requested.
- Early consultation with Orkney Islands Council Development Management would be recommended to determine the likely consenting requirements and supporting information necessary to inform the Planning process. Also, consultation with the Marine Scotland would be required in relation to the requirement for marine licences.
- Liaison with Historic Scotland is undertaken at an early stage as the Churchill Barriers are listed as HER sites and works to them or near them may be restricted.

On the condition that works to the barriers is agreed in principle, the following recommendations will inform the design phase of the project:

- A detailed historic environment assessment is likely to determine the potential impacts of the proposed project on heritage features within the surrounding area. This assessment would be prepared in line with the Institute for Archaeologists (1999) Standard and Guidance for Archaeological Desk-based Assessment, and would be carried out with reference to the relevant legislative and planning frameworks. A field reconnaissance survey would also be required to assess the condition of the known sites, to identify further sites of heritage significance or archaeological potential, and to identify potential effects (both direct and indirect) of the scheme. Changes to tidal flows on a local scale could have implications for scour and sedimentation which may have adverse impacts on buried heritage features within close proximity to the Barriers. This should be conducted in the design phase to inform the option development.
- A Preliminary Ecological Appraisal (PEA), following Institute of Ecology and Environmental Management guidelines (CIEEM, 2013), would be required to provide detailed baseline ecological data and will identify possible ecological constraints and opportunities, and potential mitigation measures of the preferred option. The PEA would include an Extended Phase I Habitat Survey following Joint Nature Conservation Committee (JNCC) methodology. The PEA would inform the requirement for further Ecological Impact Assessment (EcIA) and protected species surveys. This should be undertaken within the early stages of design development.
- Interventions to the form and functioning of the coastal environment require assessment to ensure that EU Water Framework Directive objectives are not compromised. Therefore, a coastal processes audit is recommended to assess the impacts of the scheme on the coastal processes in the area, including sediment flow and water quality. Information gathered from the assessment would allow a conceptual model of local system function to be developed, which would provide important information concerning the coastal system and would enable the project to be assessed against sustainability objectives.
- A landscape and visual impact assessment would need to be undertaken to assess the potential significant landscape impacts associated with the project. This should be

undertaken in accordance with the Guidelines for Landscape and Visual Impact Assessment 3rd edition (2013) published by the Landscape Institute and the Institute of Environmental Management and Assessment. This would include the identification of landscape and visual receptors within the study area, and would include a description of the magnitude of impacts arising from the development on the landscape environment and visual amenity. It may be more appropriate to undertake this once details of the designed option have been developed further in the design development phase.

- The potential impacts associated with the construction phase of the project would need to be considered due to the potential risks to water quality. Appropriate construction working methods and pollution prevention measures would need to be identified to ensure the risks to the environment are effectively managed. This may be best considered at the detailed design stage. Furthermore maintaining traffic flow within the area, to limit the adverse impacts on the local population, will need to be incorporated into the design.

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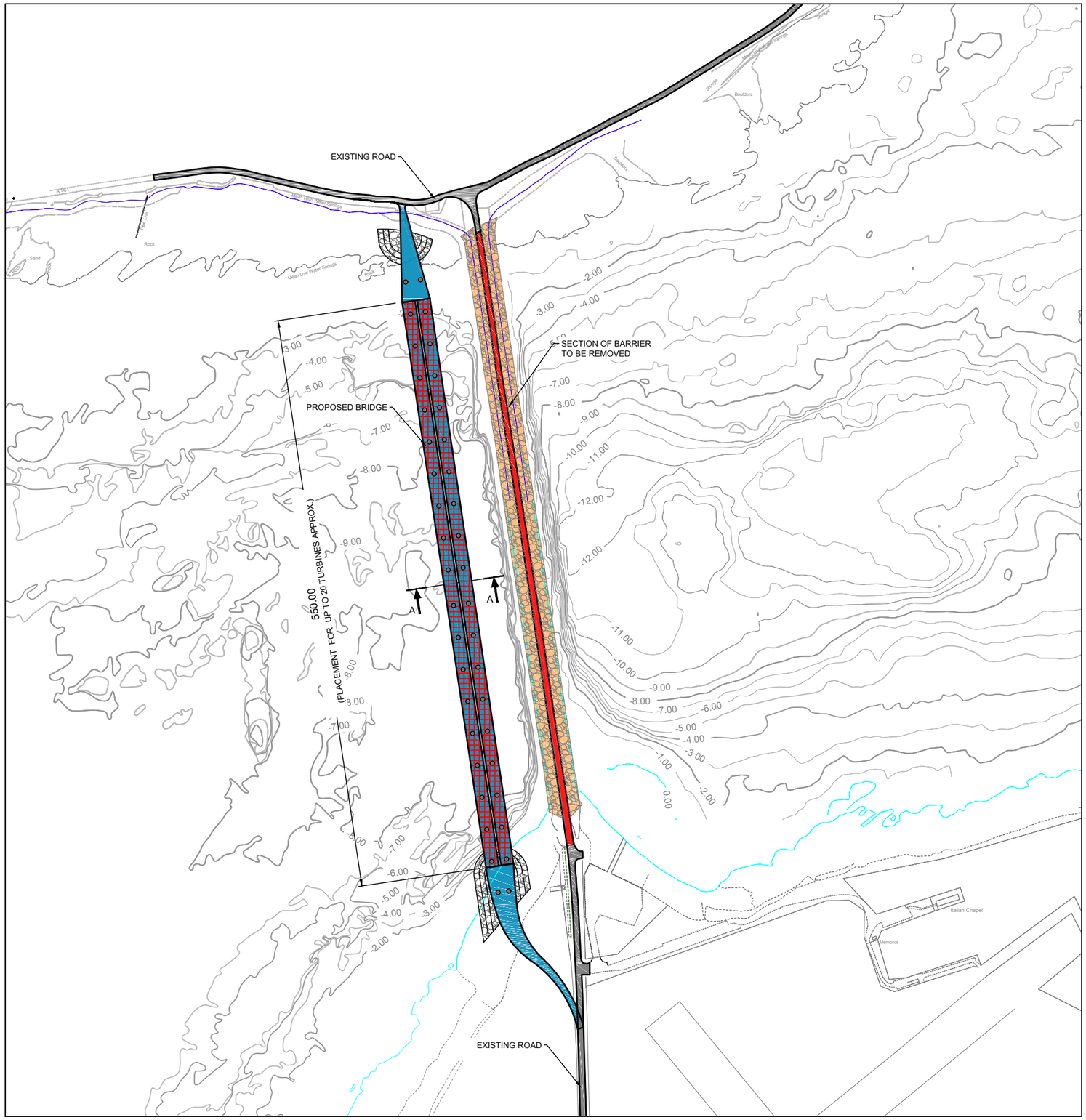
Appendix

The following appendices provide indicative drawings for the options discussed within this report. Of note, the options are likely to change through the progression of the project within the design phase.

A Bridge at Barrier 1



PLAN
SCALE 1:2000

LOCATION PLAN
SCALE 1:125000

LEGEND

- EXISTING ROAD
- PROPOSED ROAD
- EXISTING ROAD TO BE REMOVED
- PROPOSED BRIDGE
- SECTION OF BARRIER TO BE REMOVED

General Notes

1. All dimensions in metres unless otherwise stated and levels in metres above Chart Datum.
2. Do not scale from this drawing.
3. This drawing is to be read in conjunction with drawing 1202
4. All works adjacent to the coast will be carried out with care to minimise the risk of pollution adhering to Pollution Prevention Guidelines.
5. OIC to make appropriate arrangements for licences for undertaking construction, from Marine Scotland Licensing Operations Team (MSLOT) in accordance with Marine (Scotland) Act 2010.
6. The electronic model of this drawing is not to be used for setting out.
7. Bathymetric survey provided by OIC.
8. Design parameters;

   Design storm event - 200 years + CC

   Design life - 100 years

Hazards Summary

Construction & Operation:

- Restricted access and egress through narrow roads in Orkney
- Narrow causeway limiting works traffic movements (may have to consider alternative locations for plant construction)
- Working adjacent to shipwrecks
- Potential unexploded ordnance in proximity of site
- Working adjacent to public right of way
- Working within a beach area
- Working within a tidal environment
- Working in a high current environment
- Working in an exposed coastal environment
- Placement of rock armour (all level surveys should be completed remotely)
- Unknown ground conditions
- Services information currently unknown

Environmental:

- Pollution hazards associated with working near the sea
- Risk of damage to flora and fauna

It is assumed that all works will be completed by a competent contractor and therefore all normal risks associated with construction works will be considered

Rev.	Modifications	Date	Drawn	Designed	Checked	Approved
A	Bridge full lenght, North loop deleted legend updated	05/01/2016	SO	SF	GK	DB

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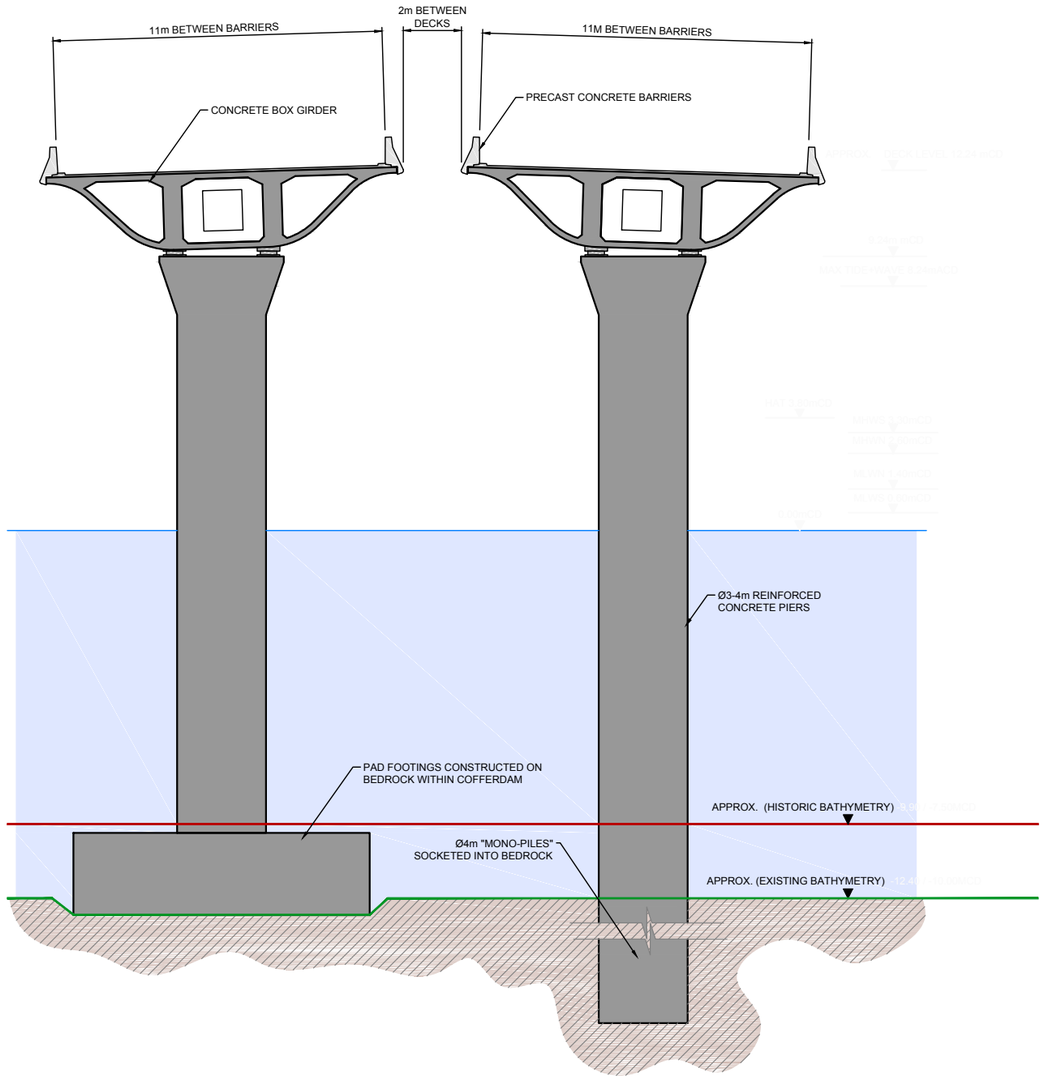
ORKNEY ISLANDS COUNCIL

CHURCHILL BARRIER No.1
PROPOSED BRIDGE
PLAN

Scale: As shown @ A1	Drawn:	S.Ortigosa	17/12/15
	Designed:	S. Farrar	17/12/15
	Checked:	G. Kenn	17/12/15
	Approved:	D. Bassett	17/12/15

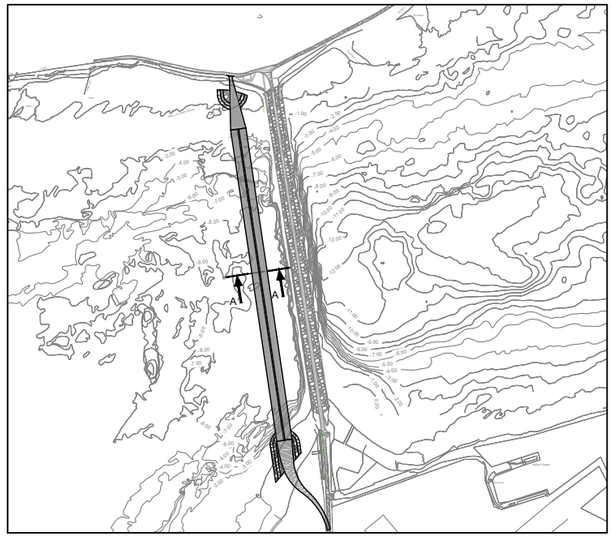
Digital File Name: 2013s7185-1201 Bridge Op Plan.dwg

Drawing Number:	Rev.:	Sheet No.:	Status:
1201	B.1	1 of 1	Concept



TYPICAL SECTION (B-B)
SCALE 1:100

ILLUSTRATIVE DESIGN OF BRIDGE SHOWING DIFFERENT FOUNDATION SOLUTIONS



LOCATION PLAN
SCALE 1:5000

General Notes

1. All dimensions in metres unless otherwise stated and levels in metres above Chart Datum.
2. Do not scale from this drawing.
3. this drawing is to be read in conjunction with drawing 1201
4. All works adjacent to the coast will be carried out with care to minimise the risk of pollution adhering to Pollution Prevention Guidelines.
5. OIC to make appropriate arrangements for licences for undertaking construction, from Marine Scotland Licensing Operations Team (MSLOT) in accordance with Marine (Scotland) Act 2010.
6. The electronic model of this drawing is not to be used for setting out.
7. Bathymetric survey provided by OIC.
8. Design parameters;

   Design storm event - 200 years + CC

   Design life - 100 years

Hazards Summary
Construction & Operation: • Restricted access and egress through narrow roads in Orkney • Narrow causeway limiting works traffic movements (may have to consider alternative locations for plant construction) • Working adjacent to shipwrecks • Potential unexploded ordnance in proximity of site • Working adjacent to public right of way • Working within a beach area • Working within a tidal environment • Working in a high current environment • Working in an exposed coastal environment • Placement of rock armour (all level surveys should be completed remotely) • Unknown ground conditions • Services information currently unknown
Environmental: • Pollution hazards associated with working near the sea • Risk of damage to flora and fauna
It is assumed that all works will be completed by a competent contractor and therefore all normal risks associated with construction works will be considered

Rev.	Modifications	Date	Drawn	Designed	Checked	Approved
A	Barrier section & legend removed	05/01/2016	SO	SF	GK	DB

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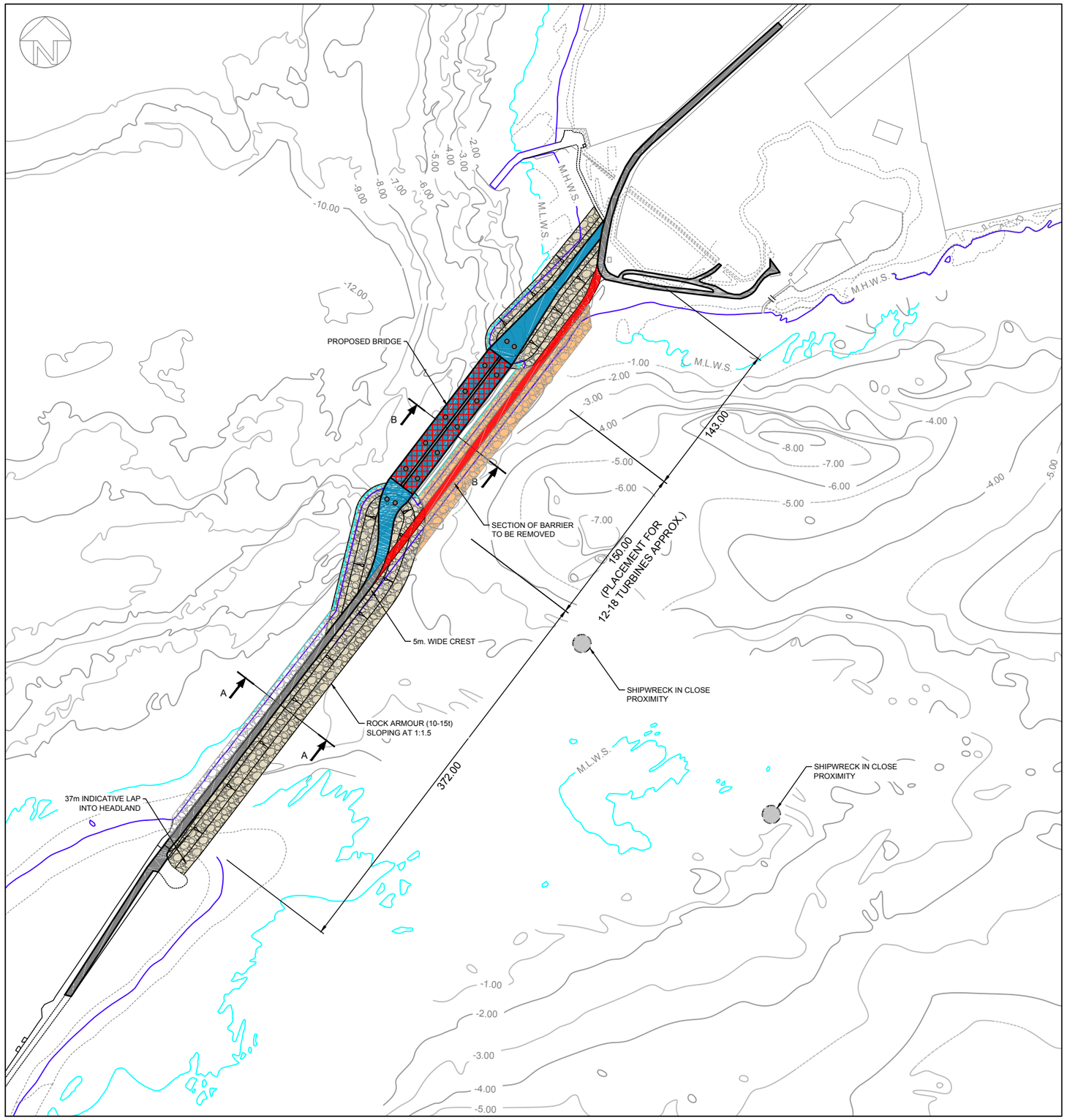
CHURCHILL BARRIER No.1
PROPOSED BRIDGE SECTIONS

Scale: As shown @ A1	Drawn:	S.Ortigosa	17/12/15
	Designed:	S. Farrar	17/12/15
	Checked:	G. Kenn	17/12/15
	Approved:	D. Bassett	17/12/15

Digital File Name: 2013s7185-1202_Bridge Op Sections.dwg

Drawing Number:	Rev.:	Sheet No.:	Status:
1202	B.1	1 of 1	Concept

B Bridge at Barrier 2



PLAN
SCALE 1:2000

LOCATION PLAN
SCALE 1:125000

LEGEND

- EXISTING ROAD
- PROPOSED ROAD
- EXISTING ROAD TO BE REMOVED
- PROPOSED BRIDGE
- EXISTING BARRIER
- PROPOSED ROCK ARMOUR REVETMENT / REFACING
- SECTION OF BARRIER REMOVED
- APPROXIMATE SHIP WRECK LOCATION
- MHWS - MEAN HIGH WATER SPRING
- MLWS - MEAN LOW WATER SPRING

Notes

1. Pre-barrier bed level is thought to vary between -9.00 and 0.00mCD. For the purposes of drawing sections, a conservative depth for each section has been selected for structural foundation level.
2. Sand level varies at between -4.00 and 1.00mCD so required volume of excavated sand unknown.
3. All primary armour to be sourced from standard European grading of 10-15 tonne (D_{n50} = 1.67m).
4. All filter layer armour to be sourced from standard European grading of 1-3 tonne (D_{n50} = 90m).
5. Core to be constructed of suitably permeable low grade quarry run.
6. Interface with existing concrete blocks only considered at a conceptual level and will require significant investigation during detailed design.

General Notes

1. All dimensions in metres unless otherwise stated and levels in metres above Chart Datum.
2. Do not scale from this drawing.

This drawing is to be read in conjunction with drawing 2202

3. All works adjacent to the coast will be carried out with care to minimise the risk of pollution adhering to Pollution Prevention Guidelines.
4. OIC to make appropriate arrangements for licences for undertaking construction, from Marine Scotland Licensing Operations Team (MSLOT) in accordance with Marine (Scotland) Act 2010.
5. The electronic model of this drawing is not to be used for setting out.
6. Bathymetric survey provided by OIC.
7. Design parameters;

   Design storm event - 200 years + CC

   Design life - 100 years

Hazards Summary

Construction & Operation:

- Restricted access and egress through narrow roads in Orkney
- Narrow causeway limiting works traffic movements (may have to consider alternative locations for plant construction)
- Working adjacent to shipwrecks
- Potential unexploded ordnance in proximity of site
- Working adjacent to public right of way
- Working within a beach area
- Working within a tidal environment
- Working in a high current environment
- Working in an exposed coastal environment
- Placement of rock armour (all level surveys should be completed remotely)
- Unknown ground conditions
- Services information currently unknown

Environmental:

- Pollution hazards associated with working near the sea
- Risk of damage to flora and fauna

It is assumed that all works will be completed by a competent contractor and therefore all normal risks associated with construction works will be considered

Rev.	Modifications	Date	Drawn	Designed	Checked	Approved
A	Same solution but some minor changes	05/01/2016	SO	SF	SF	DB

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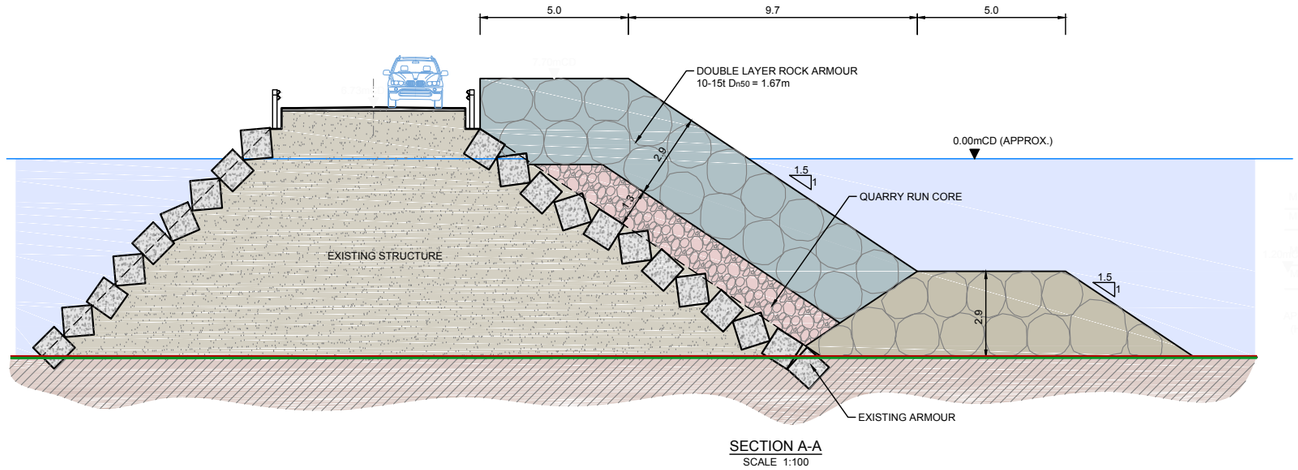
CHURCHILL BARRIER No. 2
PROPOSED BRIDGE & REFACING BARRIER
PLAN

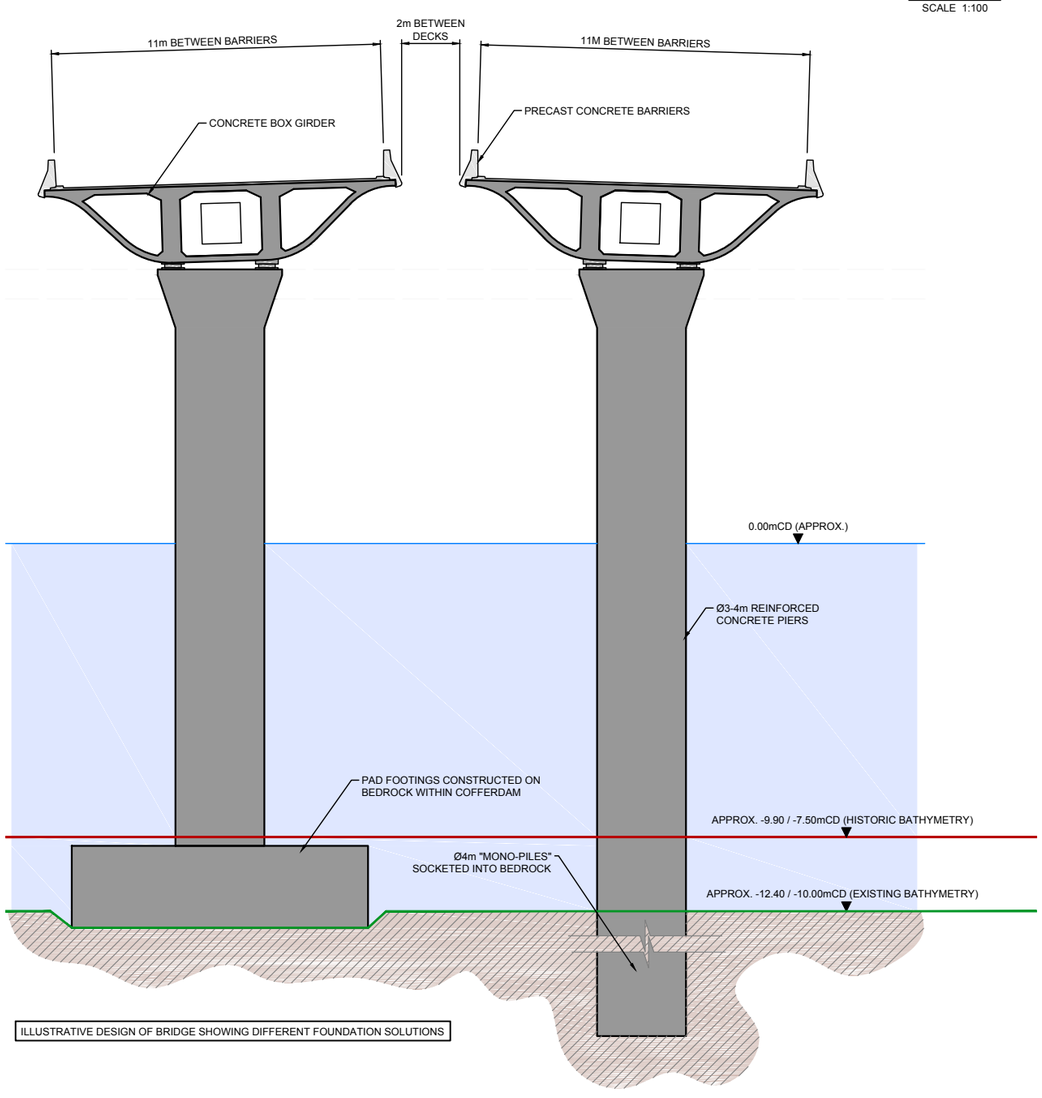
Scale: As shown @ A1	Drawn: S.Ortigosa	17/12/15
	Designed: S. Farrar	17/12/15
	Checked: S.Farrar	17/12/15
	Approved: D. Bassett	17/12/15

Digital File Name: 2013s7185-2201 Bridge Op Plan.dwg

Drawing Number:	Rev.:	Sheet No.:	Status:
2201	B	1 of 1	Concept

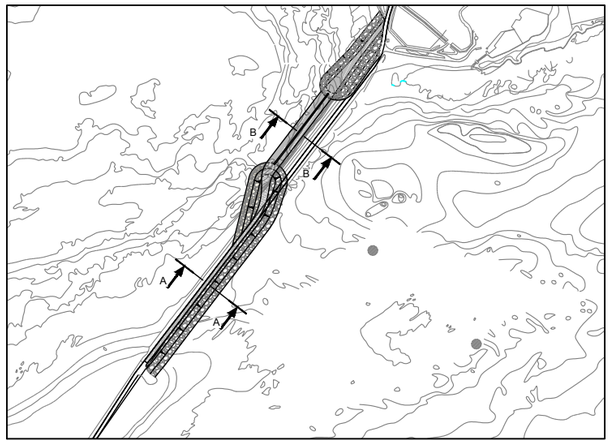


SECTION A-A
SCALE 1:100



ILLUSTRATIVE DESIGN OF BRIDGE SHOWING DIFFERENT FOUNDATION SOLUTIONS

SECTION B-B
SCALE 1:100



LOCATION PLAN
SCALE 1:5000

LEGEND

- DOUBLE LAYER ROCK ARMOUR
- FILTER LAYER ROCK ARMOUR
- QUARRY RUN CORE
- EXISTING STRUCTURE
- HISTORIC BATHYMETRY
- EXISTING BATHYMETRY

General Notes

1. All dimensions in metres unless otherwise stated and levels in metres above Chart Datum.
2. Do not scale from this drawing.

This drawing is to be read in conjunction with drawing 2201

3. All works adjacent to the coast will be carried out with care to minimise the risk of pollution adhering to Pollution Prevention Guidelines.
4. OIC to make appropriate arrangements for licences for undertaking construction, from Marine Scotland Licensing Operations Team (MSLOT) in accordance with Marine (Scotland) Act 2010.
5. The electronic model of this drawing is not to be used for setting out.
6. Bathymetric survey provided by OIC.
7. Design parameters;

   Design storm event - 200 years + CC

   Design life - 100 years

Hazards Summary

Construction & Operation:

- Restricted access and egress through narrow roads in Orkney
- Narrow causeway limiting works traffic movements (may have to consider alternative locations for plant construction)
- Working adjacent to shipwrecks
- Potential unexploded ordnance in proximity of site
- Working adjacent to public right of way
- Working within a beach area
- Working within a tidal environment
- Working in a high current environment
- Working in an exposed coastal environment
- Placement of rock armour (all level surveys should be completed remotely)
- Unknown ground conditions
- Services information currently unknown

Environmental:

- Pollution hazards associated with working near the sea
- Risk of damage to flora and fauna

It is assumed that all works will be completed by a competent contractor and therefore all normal risks associated with construction works will be considered

Rev.	Modifications	Date	Drawn	Designed	Checked	Approved
A	Ground levels changed according bathymetry data	27/11/14	SV	SF	SF	DB

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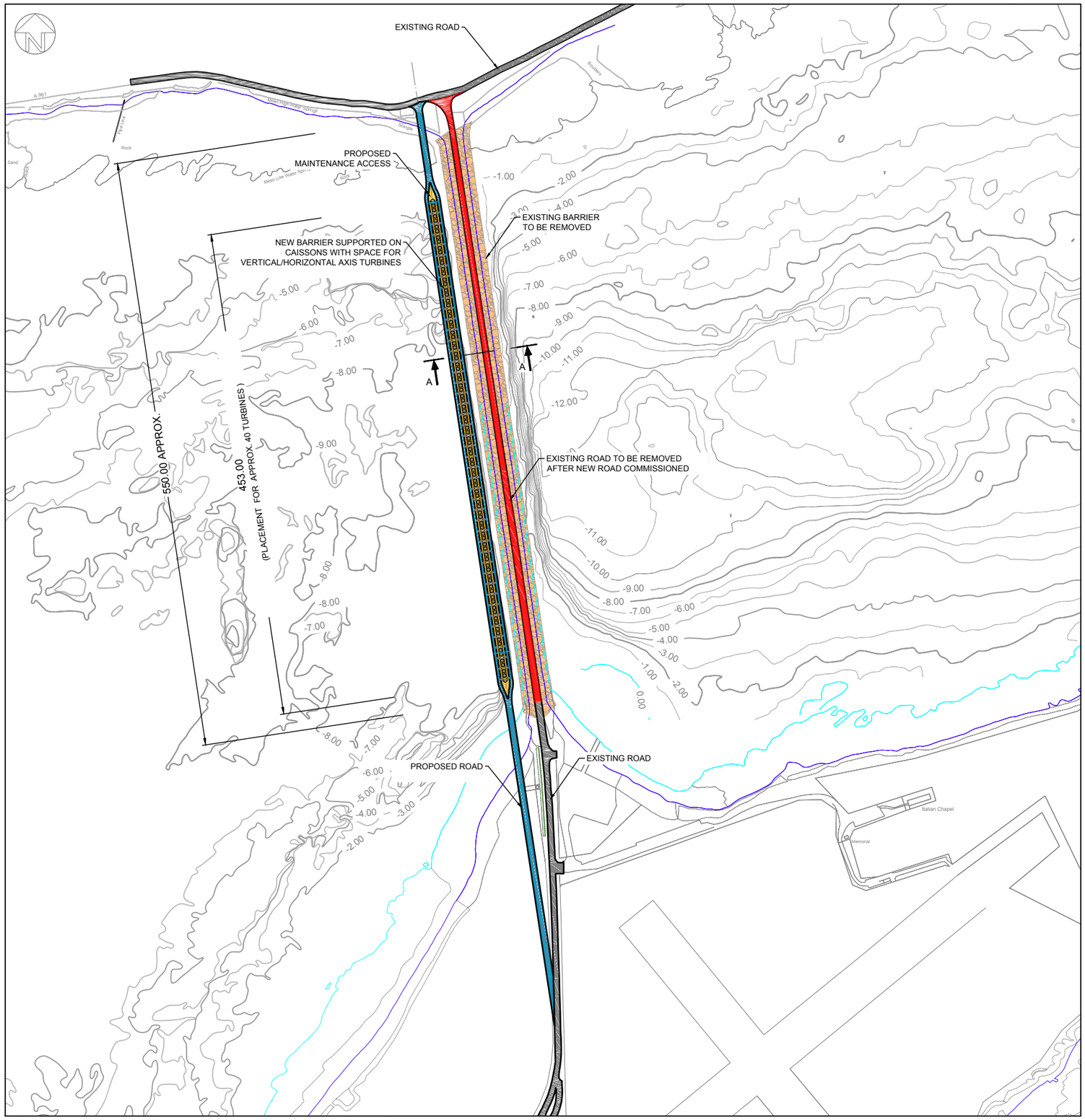
CHURCHILL BARRIER No.2
PROPOSED BRIDGE & REFACING BARRIER SECTIONS

Scale: As shown @ A1	Drawn: S.Ortigosa	17/12/15
	Designed: S. Farrar	17/12/15
	Checked: S.Farrar	17/12/15
	Approved: D. Bassett	17/12/15

Digital File Name: 2013s7185-2202_Bridge Op Sections.dwg

Drawing Number:	Rev.:	Sheet No.:	Status:
2202	B	1 of 1	Concept

C Energy Capture at 1 (Turbines in Caissons)



PLAN
SCALE 1:2000

LOCATION PLAN
SCALE 1:125000

LEGEND

- EXISTING ROAD
- PROPOSED ROAD
- PROPOSED MAINTENANCE ACCESS
- EXISTING ROAD TO BE REMOVED
- EXISTING BARRIER TO BE REMOVED
- PROPOSED CAISSONS FOR HORIZONTAL/VERTICAL AXIS TURBINES

General Notes

1. All dimensions in metres unless otherwise stated and levels in metres above Chart Datum.
2. Do not scale from this drawing.
3. This drawing is to be read in conjunction with sheet 1102
4. All works adjacent to the coast will be carried out with care to minimise the risk of pollution adhering to Pollution Prevention Guidelines.
5. OIC to make appropriate arrangements for licences for undertaking construction, from Marine Scotland Licensing Operations Team (MSLOT) in accordance with Marine (Scotland) Act 2010.
6. The electronic model of this drawing is not to be used for setting out.
7. Bathymetric survey provided by OIC.
8. Design parameters;

   Design storm event - 200 years + CC.

   Design life - 100 years.

9. Designs to be refined depending on appropriate technology.

Hazards Summary

Construction & Operation:

- Restricted access and egress through narrow roads in Orkney
- Narrow causeway limiting works traffic movements (may have to consider alternative locations for plant construction)
- Working adjacent to shipwrecks
- Potential unexploded ordnance in proximity of site
- Working adjacent to public right of way
- Working within a beach area
- Working within a tidal environment
- Working in a high current environment
- Working in an exposed coastal environment
- Placement of rock armour (all level surveys should be completed remotely)
- Unknown ground conditions
- Services information currently unknown

Environmental:

- Pollution hazards associated with working near the sea
- Risk of damage to flora and fauna

It is assumed that all works will be completed by a competent contractor and therefore all normal risks associated with construction works will be considered

Rev.	Modifications	Date	Drawn	Designed	Checked	Approved
A	New barrier deleted & caissons added	05/01/2016	SO	SF	SF	DB

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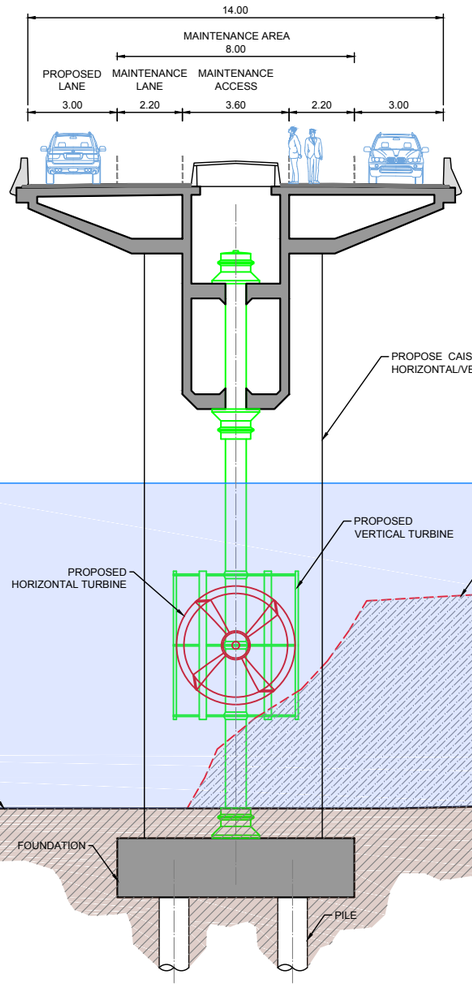
CHURCHILL BARRIER No.1
PROPOSED CAISSONS BESIDE EXISTING BARRIER
PLAN

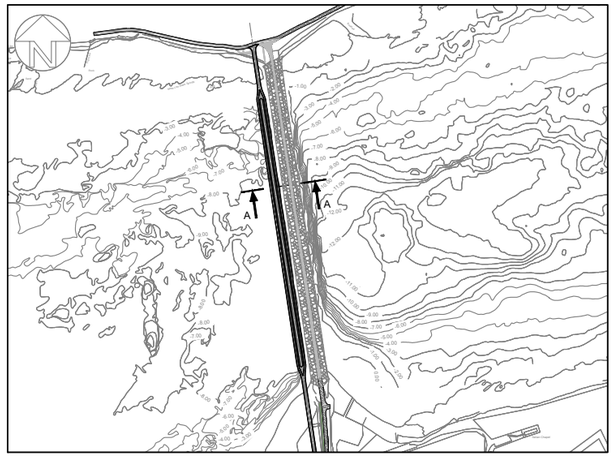
Scale: As shown @ A1	Drawn: S.Ortigosa	17/12/15
	Designed: S.Farrar	17/12/15
	Checked: S.Farrar	17/12/15
	Approved: D. Bassett	17/12/15

Digital File Name: 2013s7185-1101 Culvert Plan.dwg

Drawing Number:	Rev.:	Sheet No.:	Status:
1101	B.1	1 of 1	Concept



SECTION A-A
SCALE 1:100



LOCATION PLAN
SCALE 1:5000

General Notes

1. All dimensions in metres unless otherwise stated and levels in metres above Chart Datum.
2. Do not scale from this drawing.
3. This drawing is to be read in conjunction with drawing 1101
4. All works adjacent to the coast will be carried out with care to minimise the risk of pollution adhering to Pollution Prevention Guidelines.
5. OIC to make appropriate arrangements for licences for undertaking construction, from Marine Scotland Licensing Operations Team (MSLOT) in accordance with Marine (Scotland) Act 2010.
6. The electronic model of this drawing is not to be used for setting out.
7. Bathymetric survey provided by OIC.
8. Design parameters;

   Design storm event - 200 years + CC.

   Design life - 100 years.
9. Designs to be refined depending on appropriate technology.

Hazards Summary
Construction & Operation:
• Restricted access and egress through narrow roads in Orkney
• Narrow causeway limiting works traffic movements (may have to consider alternative locations for plant construction)
• Working adjacent to shipwrecks
• Potential unexploded ordnance in proximity of site
• Working adjacent to public right of way
• Working within a beach area
• Working within a tidal environment
• Working in a high current environment
• Working in an exposed coastal environment
• Placement of rock armour (all level surveys should be completed remotely)
• Unknown ground conditions
• Services information currently unknown
Environmental:
• Pollution hazards associated with working near the sea
• Risk of damage to flora and fauna
It is assumed that all works will be completed by a competent contractor and therefore all normal risks associated with construction works will be considered

Rev.	Modifications	Date	Drawn	Designed	Checked	Approved
A	Ground levels changed according bathymetry data. Turbines solution added	05/01/2016	SV	SF	SF	DB

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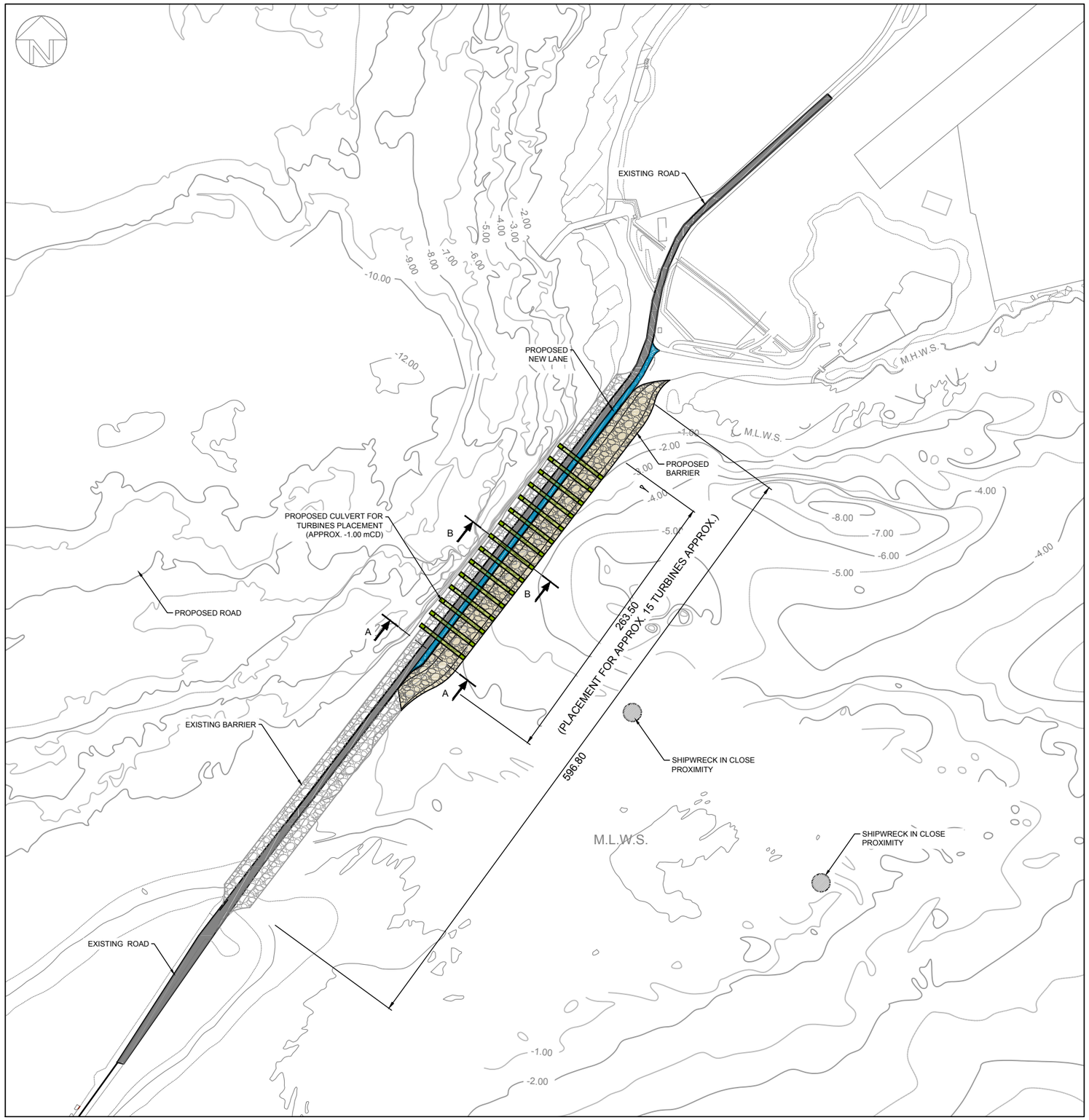
CHURCHILL BARRIER No.1
PROPOSED CAISSONS BESIDE EXISTING BARRIER SECTIONS

Scale: As shown @ A1	Drawn: S.Ortigosa	17/12/15
	Designed: S. Farrar	17/12/15
	Checked: S.Farrar	17/12/15
	Approved: D. Bassett	17/12/15

Digital File Name: 2013s7185-1102_Culvert Sections.dwg

Drawing Number:	Rev.:	Sheet No.:	Status:
1102	B.1	1 of 1	Concept

D Energy Capture at 2 (Culverts)



PLAN
SCALE 1:2000

LOCATION PLAN
SCALE 1:125000

LEGEND

- EXISTING ROAD
- PROPOSED NEW LANE
- EXISTING BARRIER
- PROPOSED BARRIER
- CULVERT FOR TURBINES PLACEMENT

General Notes

1. All dimensions in metres unless otherwise stated and levels in metres above Chart Datum.
2. Do not scale from this drawing.
3. This drawing is to be read in conjunction with drawing 2102
4. All works adjacent to the coast will be carried out with care to minimise the risk of pollution adhering to Pollution Prevention Guidelines.
5. OIC to make appropriate arrangements for licences for undertaking construction, from Marine Scotland Licensing Operations Team (MSLOT) in accordance with Marine (Scotland) Act 2010.
6. The electronic model of this drawing is not to be used for setting out.
7. Bathymetric survey provided by OIC.
8. Design parameters;

   Design storm event - 200 years + CC

   Design life - 100 years

Hazards Summary

Construction & Operation:
- Restricted access and egress through narrow roads in Orkney
- Narrow causeway limiting works traffic movements (may have to consider alternative locations for plant construction)
- Working adjacent to shipwrecks
- Potential unexploded ordnance in proximity of site
- Working adjacent to public right of way
- Working within a beach area
- Working within a tidal environment
- Working in a high current environment
- Working in an exposed coastal environment
- Placement of rock armour (all level surveys should be completed remotely)
- Unknown ground conditions
- Services information currently unknown

Environmental:
- Pollution hazards associated with working near the sea
- Risk of damage to flora and fauna

It is assumed that all works will be completed by a competent contractor and therefore all normal risks associated with construction works will be considered

Rev.	Modifications	Date	Drawn	Designed	Checked	Approved
A	Refaced the whole barrier and culverts added	05/01/2016	SO	SF	SF	DB

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for

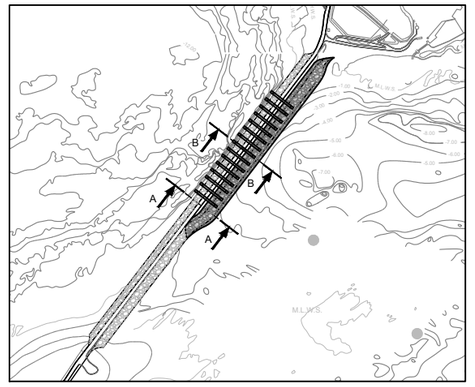
ORKNEY ISLANDS COUNCIL

CHURCHILL BARRIER No.2
PROPOSED CULVERT & REFACING BARRIER
PLAN

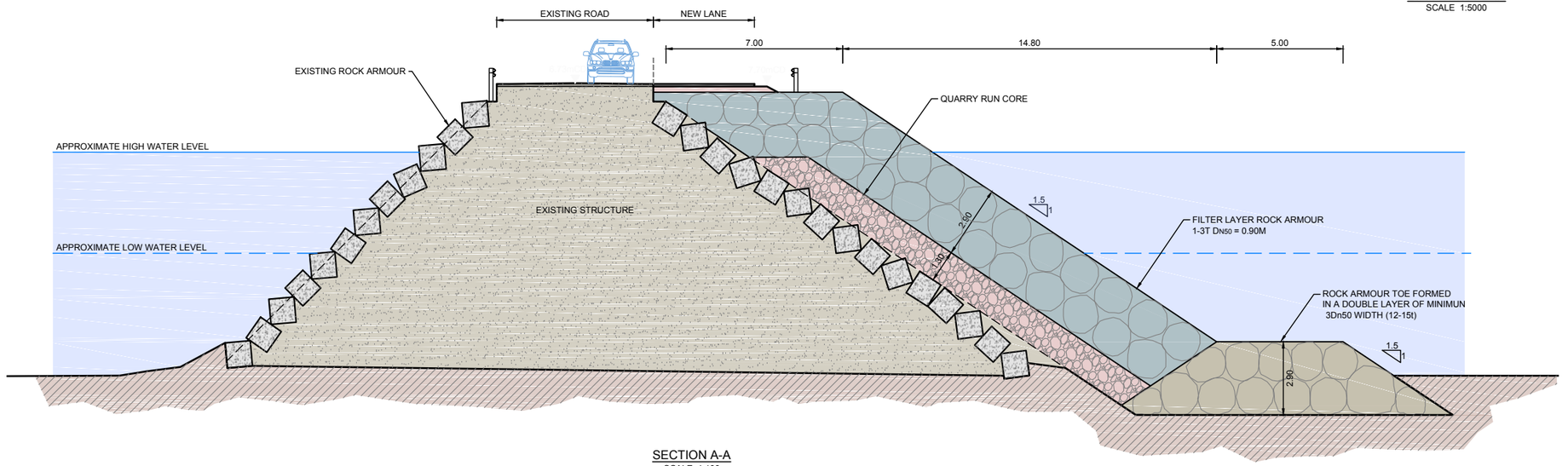
Scale: As shown @ A1	Drawn: S.Ortigosa	17/12/15
	Designed: S.Farrar	17/12/15
	Checked: S.Farrar	17/12/15
	Approved: D. Bassett	17/12/15

Digital File Name: 2013s7185-2101 Culvert Plan.dwg

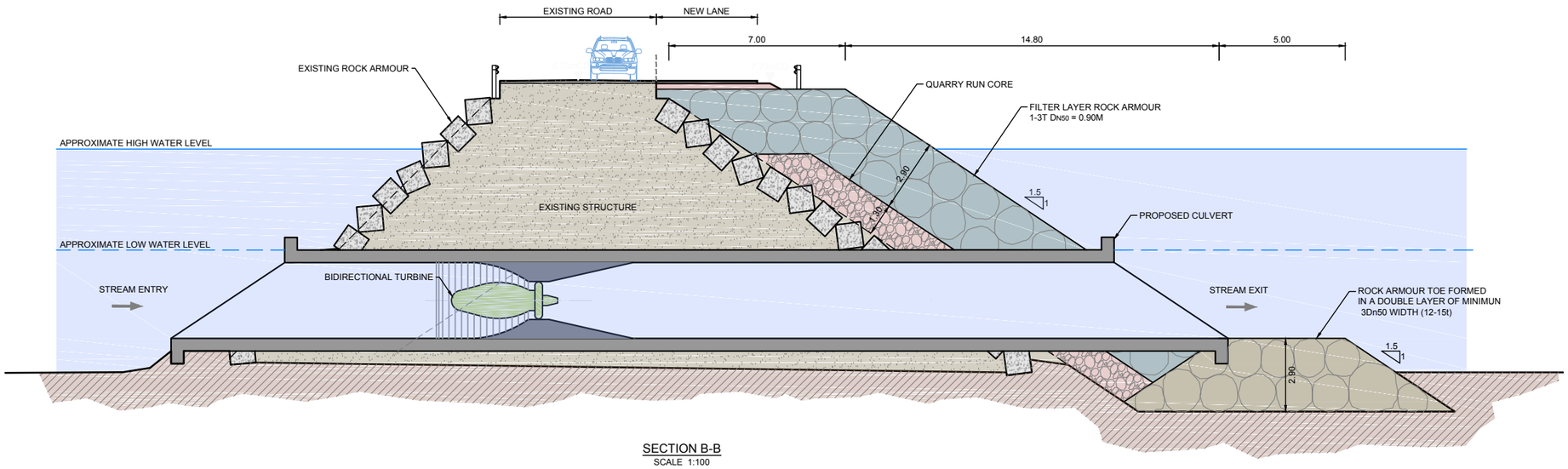
Drawing Number:	Rev.:	Sheet No.:	Status:
2101	B	1 of 1	Concept



LOCATION PLAN
SCALE 1:5000



SECTION A-A
SCALE 1:100



SECTION B-B
SCALE 1:100

General Notes

1. All dimensions in metres unless otherwise stated and levels in metres above Chart Datum.
2. Do not scale from this drawing.
3. This drawing is to be read in conjunction with drawing 2101
4. All works adjacent to the coast will be carried out with care to minimise the risk of pollution adhering to Pollution Prevention Guidelines.
5. OIC to make appropriate arrangements for licences for undertaking construction, from Marine Scotland Licensing Operations Team (MSLOT) in accordance with Marine (Scotland) Act 2010.
6. The electronic model of this drawing is not to be used for setting out.
7. Bathymetric survey provided by OIC.
8. Design parameters;

   Design storm event - 200 years + CC

   Design life - 100 years

Hazards Summary

Construction & Operation:
- Restricted access and egress through narrow roads in Orkney
- Narrow causeway limiting works traffic movements (may have to consider alternative locations for plant construction)
- Working adjacent to shipwrecks
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- Unknown ground conditions
- Services information currently unknown

Environmental:
- Pollution hazards associated with working near the sea
- Risk of damage to flora and fauna

It is assumed that all works will be completed by a competent contractor and therefore all normal risks associated with construction works will be considered

Rev.	Modifications	Date	Drawn	Designed	Checked	Approved
A	Refaced the whole barrier and culverts added	05/01/2016	SO	SF	SF	DB

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for

ORKNEY ISLANDS COUNCIL

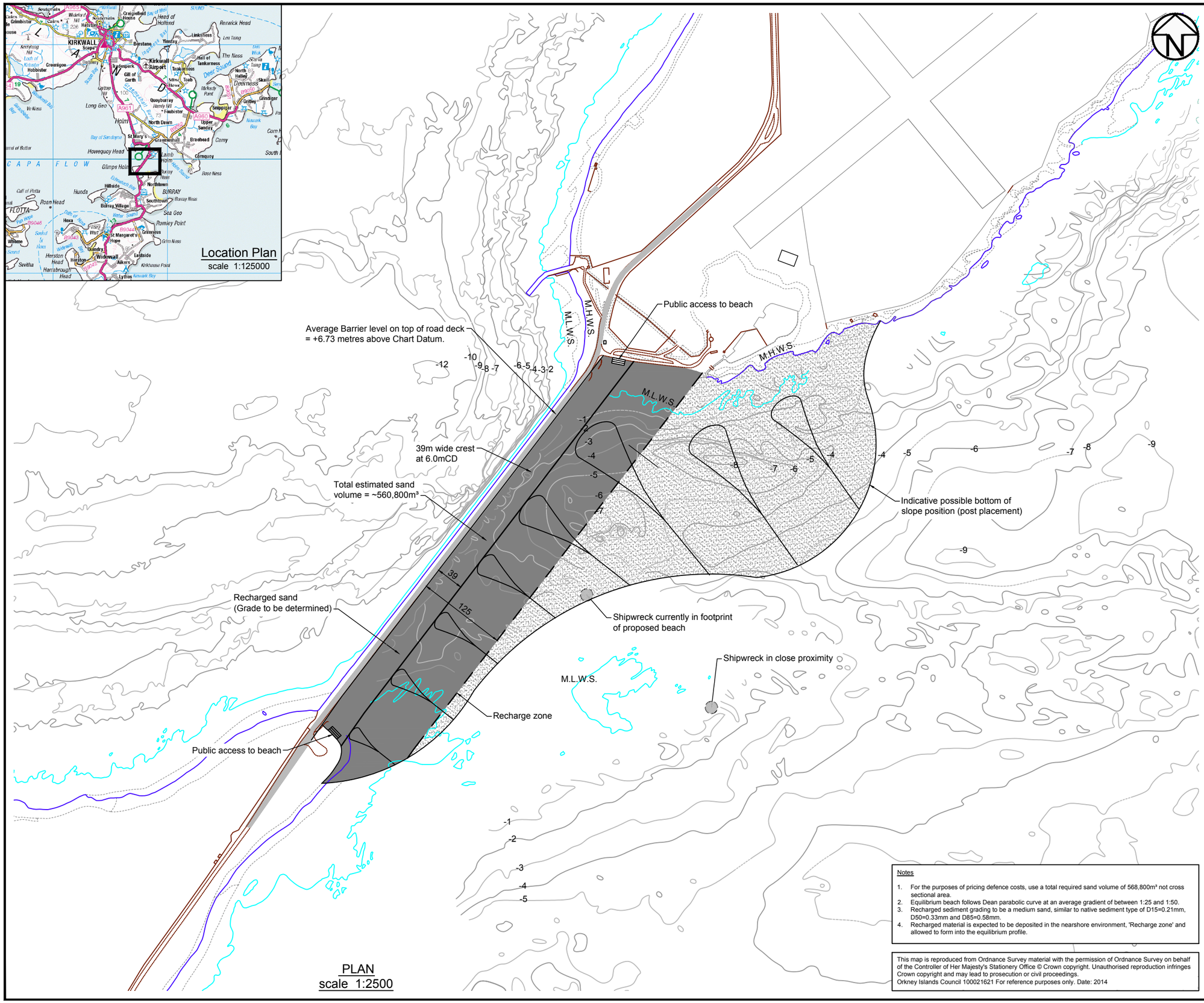
CHURCHILL BARRIER No.2
PROPOSED CULVERT & REFACING BARRIER SECTIONS

Scale: As shown @ A1	Drawn: S.Ortigosa	17/12/15
	Designed: S. Farrar	17/12/15
	Checked: S.Farrar	17/12/15
	Approved: D. Bassett	17/12/15

Digital File Name: 2013s7185-2102_Culvert Sections.dwg

Drawing Number:	Rev.:	Sheet No.:	Status:
2102	B	1 of 1	Concept

E Beach Re-charge



General Notes

1. All dimensions in metres unless otherwise stated and levels in metres above Chart Datum.
2. Do not scale from this drawing.
3. This drawing is to be read in conjunction with:
   Drawing Numbers 2013s7185 - OP4 - 1002
4. All works adjacent to the coast will be carried out with care to minimise the risk of pollution adhering to Pollution Prevention Guidelines.
5. OIC to make appropriate arrangements for licences for undertaking construction, from Marine Scotland Licensing Operations Team (MSLOT) in accordance with Marine (Scotland) Act 2010.
6. The electronic model of this drawing is not to be used for setting out.
7. Bathymetric survey provided by OIC.
8. Design parameters;

   Design storm event - 200 years + CC

   Design life - 100 years

Hazards Summary

Construction & Operation:
- Working in an exposed coastal environment
- Working adjacent to shipwrecks
- Potential unexploded ordnance in proximity of site
- Damage to services during dredging
- Noise pollution and nuisance to residents during pumping
- Working adjacent to public right of way
- Public interaction with deposition sites
- Consideration of safe disposal sites for unusable material
- Working within a tidal environment
- Working in a high current environment
- Services information currently unknown

Environmental:
- Pollution hazards associated with working near the sea
- Increased turbidity and sedimentation in dredge and deposition areas
- Risk of damage to flora and fauna

It is assumed that all works will be completed by a competent contractor and therefore all normal risks associated with construction works will be considered

LEGEND

- Existing road
- Recharge zone
- Recharged sand (post placement)
- Approximate ship wreck location
- MHWS - Mean High Water Spring
- MLWS - Mean Low Water Spring

Notes

1. For the purposes of pricing defence costs, use a total required sand volume of 568,800m³ not cross sectional area.
2. Equilibrium beach follows Dean parabolic curve at an average gradient of between 1:25 and 1:50.
3. Recharged sediment grading to be a medium sand, similar to native sediment type of D15=0.21mm, D50=0.33mm and D85=0.58mm.
4. Recharged material is expected to be deposited in the nearshore environment, 'Recharge zone' and allowed to form into the equilibrium profile.

Rev.	Modifications	Date	Drawn	Designed	Checked	Approved

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for

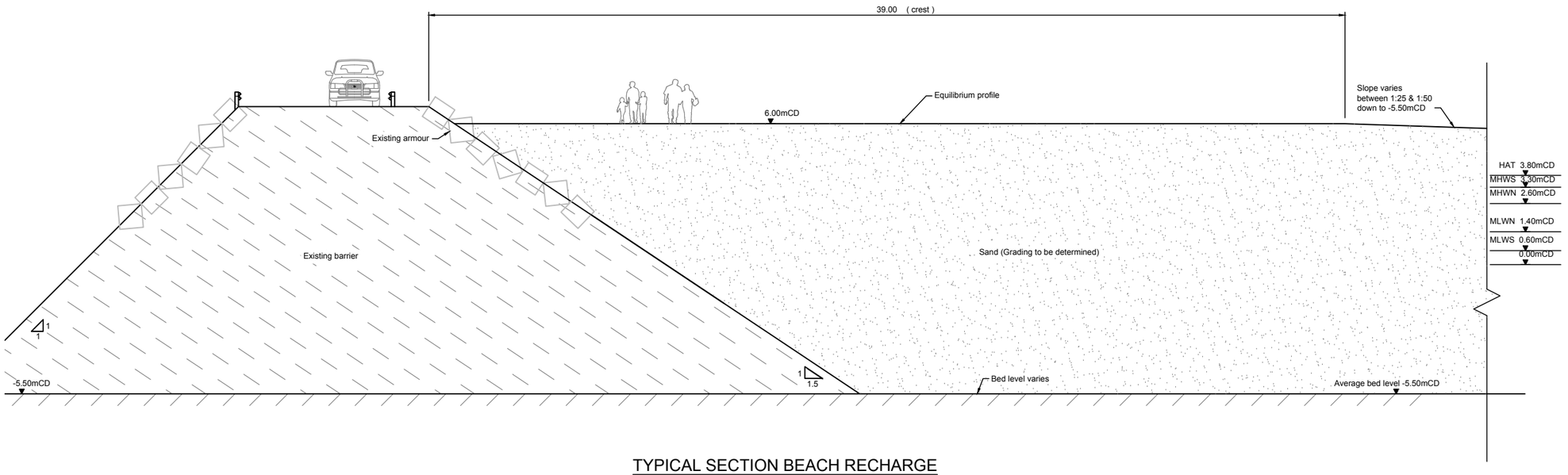
ORKNEY ISLANDS COUNCIL

CHURCHILL BARRIER No.2
BEACH RECHARGE
PLAN

Scale: As shown @ A1	Drawn:	M.J. Skinner	17/3/13
	Designed:	A. Dane	14/3/14
	Checked:	G. Kenn	27/3/14
	Approved:	D. Bassett	28/3/14

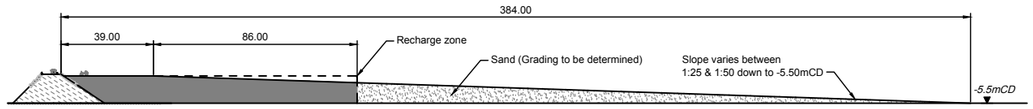
Digital File Name: 2013s7185 - OP4 - 1001

Drawing Number:	Rev.:	Sheet No.:	Status:
2013s7185 - OP4 - 1001		1 of 1	Concept



TYPICAL SECTION BEACH RECHARGE

scale 1:100



TYPICAL SECTION BEACH RECHARGE

scale 1:1250

Notes

1. For the purposes of pricing defence costs, use a total required sand volume of 568,800m3 not cross sectional area.
2. Equilibrium beach follows Dean parabolic curve at an average gradient of between 1:25 and 1:50.
3. Recharged sediment grading to be a medium sand, similar to native sediment type of D15=0.21mm, D50=0.33mm and D85=0.58mm.
4. Recharged material is expected to be deposited in the nearshore environment, 'Recharge zone' and allowed to form into the equilibrium profile.

General Notes

1. All dimensions in metres unless otherwise stated and levels in metres above Chart Datum.
2. Do not scale from this drawing.
3. This drawing is to be read in conjunction with:
   Drawing Numbers 2013s7185 - OP4 - 1001
4. All works adjacent to the coast will be carried out with care to minimise the risk of pollution adhering to Pollution Prevention Guidelines.
5. OIC to make appropriate arrangements for licences for undertaking construction, from Marine Scotland Licensing Operations Team (MSLOT) in accordance with Marine (Scotland) Act 2010.
6. The electronic model of this drawing is not to be used for setting out.
7. Bathymetric survey provided by OIC.
8. Design parameters;

   Design storm event - 200 years + CC

   Design life - 100 years

Hazards Summary

Construction & Operation:

- Working in an exposed coastal environment
- Working adjacent to shipwrecks
- Potential unexploded ordnance in proximity of site
- Damage to services during dredging
- Noise pollution and nuisance to residents during pumping
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- Services information currently unknown

Environmental:

- Pollution hazards associated with working near the sea
- Increased turbidity and sedimentation in dredge and deposition areas
- Risk of damage to flora and fauna

It is assumed that all works will be completed by a competent contractor and therefore all normal risks associated with construction works will be considered

LEGEND

- Existing barrier
- Recharge zone
- Recharged sand (post placement)

Rev.	Modifications	Date	Drawn	Designed	Checked	Approved

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for

ORKNEY ISLANDS COUNCIL

CHURCHILL BARRIER No.2
BEACH RECHARGE
SECTIONS

Scale:			
As shown @ A1	Drawn:	M.J. Skinner	17/3/14
	Designed:	A. Dane	14/3/14
	Checked:	G. Kenn	27/3/14
	Approved:	D. Bassett	28/3/14

Digital File Name: 2013s7185 - OP4 - 1002

Drawing Number:	Rev.:	Sheet No.:	Status:
2013s7185 - OP4 - 1002		1 of 1	Concept

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